POWER

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ELY C. HUTCHINSON, *Editor*

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Laugh

LIKE a message from the past comes the following, which recently turned up in the familiar handwriting of Jack Armour:

> Did you ever notice the fellow who gets up early in the morning, grabs the handles of a push-cart and shoves it about the city all day? There are bells on this wagon; he never seems to mind the weather and he always appears happy and contented. Even the condition of the streets makes no apparent difference to him. He laughs.

It was Jack's delight to make people laugh. He could find fun anywhere, chase gloom, radiate good cheer and create an atmosphere of gladness.

I have recently had an endurance trial with one of the other sort. His grouch was in-dyed and sun-proof. His trip, and probably his life, had been one succession of impositions and disagreeable experiences.

The roads were "rotten," the other drivers crabs, the hotels and service stations organized robbers. What he had told several of them with regard to their accommodations, service and charges, principally the charges, was a plenty.

He did not make a hit with our group. Just as the emanations of a merry disposition bring mirth and sunshine and enjoyment to the homeliest occasion, so the baleful influence of one grouch will mar the pleasure of an entire party.

The man with a cart pushed it around all day and laughed. The man with a high-priced car and a chauffeur to drive it for him growled. The man with a cart did a penny-picking trade, but his people were glad to see him. The man with a car had a lucrative business that ran itself while he toured, and people said "How would you like to have to live with him?"

The cartman probably ate a hunk of bread and cheese, and gave thanks. The tourist ate meals any one of which would have been a feast to the cartman and cussed the waiter.

We need more Jack Armours and Mark Tapleys.

F. R. Low

EDITORIALS

Electric Boilers

IN CANADA a number of large hydro projects have been initially developed to nearly their ultimate capacities and the surplus power has been used in electric boilers for steam production. This has made possible large developments not otherwise economical. What has been done on the Gatineau River near Ottawa illustrates one of the ways electric boilers are utilized. On this river about five hundred thousand horsepower has been developed within a few years. An industrial load was not available for all this power, and part of it is being used to supply steam to the Canadian International Paper Company's new mills. Steam-making equipment with lower operating cost than that of fuel-fired boilers was thus made possible.

Now that an industrial market has developed for part of this power, the paper company is installing a fuel-burning boiler plant. The electric boiler, however, will still be used to absorb any excess hydro power.

Sufficient electric boiler capacity to use about one million kilowatts from hydro plants has been installed in Canada and Newfoundland. In this country probably not more than one-tenth this capacity has been installed. The characteristics of our rivers, cheaper fuel and greater industrial power markets account largely for this apparent lack of interest in electric steam boilers. Notwithstanding these conditions, this type of unit has probably not been used as extensively as it might.

The A.S.M.E.

LAST WEEK marked an epoch in mechanical engineering through the celebration of the fiftieth birthday of the A.S.M.E. Those who were privileged to take part are richer in a knowledge of engineering acomplishment: the work of numerous pioneers has been revaluated in the light of their contributions to human welfare; personal contacts with fellow engineers have been extended; international relations between technical men have been strengthened; and there has resulted a new appreciation of the society as a vital force in our material and economic progress.

Aside from the foregoing aspects, and sentimental considerations, such an occasion is useful for taking stock of accomplishment as a background for future effort.

In the formation of codes and the sponsorship of standards the A.S.M.E. has done outstanding work. It has also been active in fostering research, a field in which still greater opportunity beckons. The extension of local section work and the growth of the professional divisions have resulted in the broadening of society activities to serve more completely the diversified interests of its nineteen thousand members.

The structure has been well built. May its functioning continue to be guided by usefulness to members and the profession rather than be influenced by the idea of bigness. The number of papers, meetings and committees does not measure the usefulness of an engineering society. It is the quality and timeliness of such papers and meetings that count. May the record of the second fifty years measure up to that of the first.

Training Men

"GETTING things done right" is the executive's real job, which he cannot properly accomplish without devoting much of his thought and energy to the training of his men.

Does this mean that he must conduct classes with all the paraphernalia of standardized education? Certainly not. The most effective teaching in the plant is part of the day's work. It is carried on by the judicious assignment of unfamiliar tasks to the worker with a word of explanation here and a bit of encouragement there to help him over the hard spots. The instrument man will gradually be "broken in" on keeping logs, plotting load curves and computing the day's performance ratios. The boiler-room foreman will be shown how to

compute factors of evaporation and boiler efficiencies. He may even be asked to help lay out the new boiler room. For every man, of every grade, there will be occasional tasks a little out of the ordinary, and just enough help from the boss to carry him through to success.

To the "student" these assignments will be merely new and somewhat puzzling practical jobs—things that need to be done, with no taint of school room atmosphere. To the executive in charge they will be part of a prearranged plan, carefully conceived to round out the abilities of each man in the way that will fit him to carry a larger responsibility in the operation of the plant.

The executive who does not begrudge time and thought spent on such training will be repaid manyfold another day. He will find himself heading an organization that practically runs itself in all routine matters. He will be free for the big decisions and to prepare himself for greater responsibilities.

More About Power Storage Caverns

"A CAVERN of this type," Mr. Gay estimates, "could be excavated at a cost of $4 or $5 per cubic yard." This sentence from a *Power* editorial last week, based on a news item in the previous number, reported Mr. Gay incorrectly. "Twenty-four or twenty-five dollars per cubic yard" was what he really said, we have since learned. Speaking before the Metropolitan Section of the A.S.M.E., he was discussing the feasibility of storing power as water at high temperature and pressure in deep-lying caverns hollowed out of solid rock.

Correction of this misquotation suggests a pertinent question: "Is $25 per cubic yard a fair estimate of the cost?" *Power* does not pose as an authority on excavating or tunneling, but has approached civil and mining engineers for an answer. They report that this figure seems much too high unless the work involves factors not ordinarily encountered in work of this type. The actual Moffat Tunnel unit cost, including refuse disposal, ran $4.39.

"The removal of large beds of rock from underground chambers by the 'stoping' process is essentially simple and cheap," said one mining engineer. "Several hundred tons of rock may be brought down by a single blast, and the cost rarely exceeds $3 per cubic yard.

But how about the cost of sinking a one-thousand-foot shaft? Here, admittedly, is a factor that cannot be overlooked. Shaft sinking is relatively expensive. While the cost varies greatly according to locality, dimensions, timbering requirements, etc., $20 per cubic yard may be taken as a conservatively high average figure for a deep shaft sunk through hard rock.

If one assumes this unit cost for a one-thousand-foot shaft seven by fourteen feet in section, and allows $3 per cubic yard for excavating a cylindrical cavern one hundred feet long and seventy feet in diameter, the average cost for the entire job will be $7 per cubic yard. Division of the total cost of cavern and shaft by the useful volume of the cavern would give a unit cost of $8.80 for water-storage space.

Undoubtedly, Mr. Gay wished to make his figures conservatively high, so that savings predicted could not be criticized. He may also have added a considerable sum to cover the cost of a steel lining for the cavern. It is hardly necessary to stress the point that if his estimates of construction cost are somewhat high, the desirability of this type of power storage may be even greater than his final figures would indicate.

Boiler Rating Codes

MEMBERS of the American Society of Heating & Ventilating Engineers recently expressed by letter ballot their desires in regard to the proposed revision of the code for rating steam heating boilers. These ballots have now been counted and indicate that the society is overwhelmingly in favor of the adoption of the code revisions.

The provisions of this code, which require that test results be published as part of the manufacturer's catalog data, were strenuously opposed by members of the society who also are members of the Steel Heating Boiler Institute. This organization prepared and adopted a rating code of its own before the annual meeting of the A.S.H.V.E. at which the code revisions were to be considered. The rating code for steel heating boilers is based on ten square feet per 34.5 pounds of water evaporated from and at 212 degrees.

Neither of these organizations possesses authority to enforce the rating code it has adopted. The value of the codes depends entirely upon the degree of cooperation given them by manufacturers. As the situation stands at present, the A.S.H.V.E. code is supported by the cast-iron-boiler manufacturers, while the other code is supported by the steel-heating-boiler manufacturers.

With the two widely differing codes in use, some degree of confusion must eventually follow. Therefore, it is hoped that the Steel Heating Boiler Institute will see the sounder foundation upon which the A.S.H.V.E. code is based and give it the support it deserves.

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POWER *Stands for . .*

1. **Making Power When It Should Be Made**
2. **Buying Power When It Should Be Bought**
3. **Cheaper Power Through Modern Equipment**
4. **Easier Financing of Equipment Purchases**
5. **Better Use of Byproduct Heat and Power**
6. **Operating Methods That Save Money**
7. **Less Waste in Transmission and Application**
8. **Prevention of Smoke, Within Reason**

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A.S.M.E. GOLDEN ANNIVERSARY

Marks Era of Vast Achievement

ENGINEERS from all parts of the United States and from eighteen foreign countries visited New York, Hoboken and Washington, D. C., from April 5 to 9 to take part in the celebration of the Fiftieth Anniversary of the American Society of Mechanical Engineers. In this event, probably the most colorful in the history of the society, 50 years of scientific and industrial progress was reviewed by pageant and monograph; the influence of engineering upon cultural, social, economic and political life was evaluated by the world's foremost engineers, and scenes depicting the vision of the past that led to the organization of this great society were re-enacted.

The celebration started on the morning of April 5 in New York City with the unveiling in the United Engineering Societies Building of the anniversary tablet shown at left, which was designed and executed by Julio Kilyeni, noted sculptor. It was unveiled by John Sweet of Syracuse, youthful grand-nephew of Professor John E. Sweet, one of the founders of the society.

The delegates then visited the offices of the *American Machinist*, where the preliminary meeting that led to the establishment of the society was re-enacted. Against a scenic background reproducing as faithfully as possible the appearance of the old *American Machinist* office on Fulton Street, a one-act play was presented depicting this first meeting of February, 1880.

In the afternoon the anniversary program was continued at Stevens Institute of Technology in Hoboken, N. J., where the society's organization meeting April 7, 1880, in the auditorium of Stevens Institute was commemorated with a pageant. The pageant, a vista of engineering progress, was written and directed by Dr. George Pierce Baker, director of the Department of Drama of Yale University, and presented by students of Stevens Institute.

The opening tableau, showing a group of primitive men gazing at motion pictures of waterfalls, volcanoes, the ocean in uproar and other nature studies, introduced a number of symbolic figures—mystery, curiosity, intelligence, imagination, etc. These, in turn, were followed by "control" in childhood, youth and maturity, to illustrate the evolution of human ingenuity and modern science. The five tableaus gave glimpses of the lives

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Delegates and members at ceremony in McGraw-Hill Building

"I HAVE a high appreciation of the contribution of the other professions," said President Hoover in accepting the first Hoover Medal award at the anniversary banquet, "but engineers, I insist, have a contribution to make to public service and they have an obligation to give that contribution."

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of James Watt, George Stephenson, Michael Faraday and Thomas A. Edison, as well as the re-creation of the organization meeting of the society.

A dinner was held at the Hotel Roosevelt, New York, in the evening, at which Charles M. Schwab, honorary member and past president of the society, presided. An address of welcome was given by Paul Doty, vice-president of the society, and speeches were made by Edward J. Mehren, vice-president of the McGraw-Hill Publishing Company, representing the engineering press, and by Robert I. Rees, president of the Society for the Promotion of Engineering Education, representing engineering education.

In Washington on Monday morning, April 7, a welcoming assembly was held in the National Council Chamber of the United States Chamber of Commerce Building. Ralph E. Flanders, vice-president of the society, presided and made the welcoming address. There then followed brief addresses by a delegate from each foreign country in behalf of all the delegates from his country; by the presidents of the American Society of Civil Engineers, the American Institute of Mining and Metallurgical Engineers, and the American Institute of Electrical Engineers. Palmer C. Ricketts, president of Rensselaer Polytechnic Institute spoke in behalf of American engineering educational institutions: William Butterworth, president of the Chamber of Commerce of the United States, in behalf of business organization of the United States, and then Major-General George O. Squier in behalf of various American scientific and professional societies.

In the afternoon there was a session on the "Influence of Engineering upon Civilization," when nine of the sixteen national papers covering the humanistic aspects of engineering were summarized by their distinguished authors in short addresses.

The first of these monographs, "Austria, the Land of Engineering," evaluating the influence of engineering upon cultural, social, economic and political life, was presented by Hofrat Ing. Dr. Ludwig Erhard, director of the Technisches Museum, Vienna, Austria. Dr. Erhard said that Austria, cut to one-eighth her former size following the World War, is being returned to a place of prominence by engineers. Engineers have developed deposits of low-grade lignite to partially replace lost coal lands. They are electrifying railroads to make unnecessary the importation of coal, and are intensifying agriculture and introducing labor-saving devices.

Baron Gaston S. P. de Bethune, chemical engineer and a member of the Fédération des Associations Belges d'Ingénieures, representing a staff of six eminent engineers of Belgium, gave the second monograph,

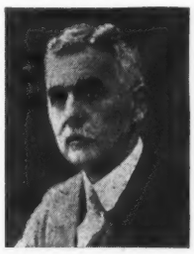
Pictorial Press

Pageant tableau: James Watt, seated, being consoled on financial difficulties by Mathew Boulton

"Half a Century of Development in Belgium." He pointed out that Belgium is a leader in the development of high-pressure boilers. She is so greatly increasing thermal power plant efficiency that electrochemical industries may be brought from the mountains, where cheap hydro-electric power is available, to her coal fields.

The third paper, "Canada and the Engineer," was presented by Brigadier General C. H. Mitchell, dean of the faculty of applied science at the University of Toronto, Canada. Canada's great growth has depended largely on the development of water power, said General Mitchell, and she looks forward to further expansion from the projected power developments on the St. Lawrence river. Her interest in this river assures her of upwards of 3,500,000 hp.

For Czechoslovakia, the fourth paper, "Engineering Achievements in Czechoslovakia," was presented by Dr. E. Zimmler, A. E., president of the Masaryk Academy of Work in Prague. Dr. Zimmler related how the first engineering school, established in 1717, the first mining school and Europe's first school for studying brewing are Czechoslovakian contributions to world engineering. Europe's first railway was also built in Czechoslovakia.

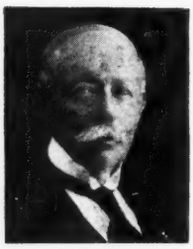


GEORGES CLAUDE, inventor, scientist and general manager of the Liquid Air Company in Paris, France, presented the fifth monograph, "Activities of Engineering Importance in France." Stressing the value of collaboration and mutual intercourse between engineers of different countries, Mr. Claude outlined under separate headings the development in France of public works, chemistry, metallurgy, electro-engineering, hydraulics, shipbuilding, mining, railroads, aviation and refrigeration. He par-

ticularly emphasized the work of Auguste C. E. Rateau in thermodynamics and the development of the turbine; progress in the generation, distribution and utilization of electricity in France; and the invention of the hydraulic turbine by Fourneyron.

DR. ING. E. N. CONRAD MATCHOSS, director of the Verein Deutscher Ingenieure, Berlin, Germany, gave the sixth paper, "Engineering Aspects of Germany." Dr. Matchoss believes that in spite of injurious effects, either real or imaginary, of the so-called machine age, there can be no turning back. The engineer is optimistic and believes in the future. Germany's great success in chemical industry is due largely to chemical research. Further than that, he said the success of all branches of engineering in the last decade have been marked by their close connection with scientific research. New and wider fields of endeavor have been discovered for mankind through the co-operation of engineers and scientists. The geographical extension of engineering over the face of the globe and the growing importance of scientific research make necessary the co-operation of all the nations of the world, for science and engineering are not confined by political boundaries. Giving and receiving, teaching and learning, are going on among all nations, and great international organizations provide the opportunity for the exchange of experience.

LOUGHNAN ST. L. PENDRED, president of the British Institution of Mechanical Engineers and editor of *The Engineer* of London, presented the seventh paper, "Some Aspects of Engineering in the United Kingdom During Fifty Years." After tracing the progress of power from the invention of the steam engine through the perfection of the steam turbine and boiler and the growth of electrical engineering, Mr. Pendred suggested that the influence mechanical engineering is exerting upon the peoples of all nations is not wholly good, because of its effect on home life and the destruction of self-reliance in the individual. The author recognized and applauded the many great services of incalculable value which the engineer in all branches has conferred upon mankind, but at the same time he deemed it folly to be blind or indifferent to sociological effects. Since it is the duty and function of the engineer to increase man's comfort and well-being, every collateral defect which may accompany the improvements which he effects by his skill and knowledge must be regarded as a diminution of the total benefit which could be secured. These considerations brought the author to the conclusion that the duty of the engineer in the immediate future is the removal of all the objectionable features which accompany his works. He desired to see man blessed with the untold benefits which engineers can confer without losing a single one of the amenities which were enjoyed in a less mechanical age. His monograph concluded with, "May the great society which today we honor, in aiding the future progress of engineering, remember that the things of the spirit are greater than those of the flesh."



SENATOR LUIGI LUIGGI of Rome, Italy, in the eighth monograph, "What Engineering Has Done and Is Doing for Italy," stated that no nation is so dependent on engineering as Italy. Senator Luiggi showed that inter-city high-speed highways under construction in the United States are already realities in Italy. There are also anti-seismic buildings, an aqueduct 1,000 miles long and a volcanic power plant in that country. Italy's well-developed hydro-electric plants, says Senator Luiggi, take the place of coal- and oil-fired steam plants of other nations. He concluded with the statement that "Engineering has been of immense benefit to humanity. Engineers are the pioneers of civilization and deserve the greatest consideration and praise for their co-operation in the advancement of the welfare and peace of mankind all over the world. Peace and engineering will really make this world a worthy place in which to live."

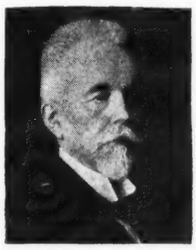
MASAWO KAMO, professor of engineering at the Tokio Imperial University and president of the Society of Mechanical Engineers, Tokio, Japan, presented the ninth paper, "Fifty Years of Engineering: Its Contribution to Japan's National Progress and to the Advancement of World Culture and Civilization," which concluded the first session on the evaluation of engineering. Dr. Kamo said that during the past 50 years engineering has accomplished more in Japan than it has in other countries in twice that time. For example, 92 per cent of her dwellings are wired for electricity and nearly every home has a radio. Unbridled streams cause no more disastrous floods because they are harnessed by huge dams which develop hydro-electric power. Her streams at the end of 1929 were developing 2,400,000 kw.

On Tuesday morning, April 8, the second part of the session devoted to the "Influence of Engineering Upon Civilization" was held, when the remaining seven national monographs were presented. Señor Ing. Norberto Dominguez gave the tenth paper, on the progress and effect of engineering on Mexico. The eleventh monograph, dealing with engineering developments in the Netherlands, was then presented by Prof. Ir. Daniel Dresden, president of the Jaffa Engine Works, Utrecht, Holland.

VILHELM NORDSTRÖM, manager of the DeLaval Steam Turbine Company, Stockholm, Sweden, presented the twelfth paper, "Industrial Developments in Denmark, Finland, Norway and Sweden." Covering a wide field, Mr. Nordström said that Europe's purest iron ore and a type of worker developed through generations have made Sweden's iron and steel industry famous. Pointing out some of the Scandinavian contributions to the progress of power, Mr. Nordström mentioned that in the field of power and heat economy there are the brothers Birger and Fredrik Ljungström, inventors of the Ljungström turbine. Johannes Ruths' name is well

known as the inventor of a new method for the storage of steam.

Next there followed the thirteenth and fourteenth monographs, on "Engineering in South America." The thirteenth, dealing with Colombia and the northern part of the continent, was written and presented by Prof. Julio Garzon Nieto, chief engineer of the Office of Longitudes in the Ministry of Foreign Affairs of Colombia. The fourteenth, dealing with Argentina, Brazil, Chile, Peru and Uruguay, was written by Prof. Donato Gaminara, member of the Pan-American Highway Commission and member of the faculty of the University of Montevideo, Uruguay, and was presented by Dr. L. S. Rowe, director-general of the Pan-American Union, Washington, D. C.



AUREL STODOLA, professor of heat engineering at the Federal Technical High School, Zurich, Switzerland, prepared the fifteenth paper, on "Development of Swiss Technical Science and Its Influence on the Economics and Culture of Switzerland During the Last Fifty Years." Dr. Stodola pointed out that engineering has made hemmed-in little Switzerland one of the most advanced countries in the world. She has nearly 2,000 miles of electrified railway. Electric power goes to 98 per cent of her inhabitants, and 1,100 million surplus kilowatts are exported annually.

The sixteenth and final monograph, on the United States, was given by Dr. Carl Grunsky, consulting engineer, of San Francisco, Calif., and president of the American Engineering Council. Following this there was a presentation by Dr. F. R. Low of "A Half-Century of Progress in Mechanical Engineering in the United States," a report prepared by the professional divisions of the A.S.M.E. and their representatives.

At noon on Tuesday a luncheon was held at the Mayflower Hotel in honor of the founders of the society, of which Ambrose Swasey, founder, honorary member and past-president of the A.S.M.E., was honorary chairman. John R. Freeman, past-president of the society, presided, and special medals were presented to the six living founders: John W. Cloud, John S. Coon, Robert F. Grimshaw, Francis H. Richards, E. H. Robbins and Ambrose Swasey.

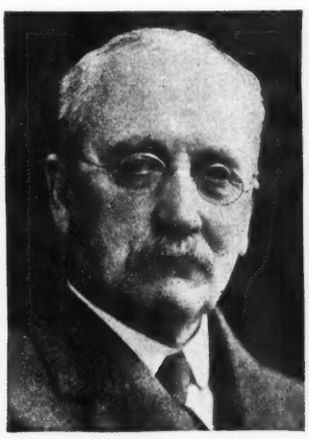
In the afternoon fiftieth anniversary medals were conferred on the sixteen men who prepared the monographs, by the chief diplomatic officer of each country represented. This occasion was also deemed unusually appropriate for the presentation of four other medals—the A.S.M.E., the Gantt, the Melville, and the Guggenheim. The A.S.M.E. medal was presented to William LeRoy Emmet, consulting engineer with the General Electric Company, for his contribution to the development of the steam turbine, by Conrad N. Lauer, vice-president of the society. The Gantt medal was presented to Fred J. Miller, industrial engineer, for distinguished achievement in scientific management, by L. P. Alford, chairman of the Gantt Medal Board. The Melville medal was presented to Joseph Wickham Roe, professor of industrial engineering at New York University, for his paper, "Principles of Jig and Fixture Practice," by Conrad N. Lauer. The Daniel Guggenheim medal was presented to Orville Wright, with his brother, Wilbur, the first to fly a heavier-than-air machine, for notable achievement in the advancement of aeronautics, by Dr. W. F. Durand, president of the Guggenheim Medal Board.

At the formal dinner on Tuesday evening in the Mayflower Hotel, Doctor Durand, past-president of the society, presided as toastmaster. Addresses were given by Charles Piez, president of the society, and Robert A. Millikan, past-president of the American Association for the Advancement of Science. Mr. Piez spoke on "The Broadening Responsibilities of the Engineer." Dr. Millikan's topic was "The Bonds Between Science and Engineering."

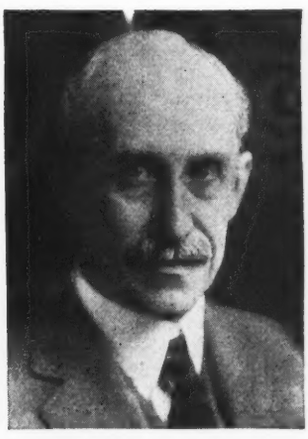
Following the speeches, the announcement and first presentation was made of the Herbert Hoover medal by the Hoover Medal Board, representing the four founder engineering societies. Dexter S. Kimball, president of the board and past-president of the A.S.M.E., presented the award to President Hoover. The Hoover gold medal has been instituted to commemorate the civic and humanitarian achievements of Herbert Hoover. From time to time it will be awarded to engineers for distinguished public service. In accepting the award President Hoover emphasized the obligation of engineers to make their contributions to public service. Of the A.S.M.E., he said that "during its span of life it has contributed a great part in the development of an art into a mighty profession upon whose capacity and fidelity rests so much of human progress."

Wednesday, April 9, the final day of the anniversary celebration, was spent by delegates on excursions to points of interest in and around Washington.

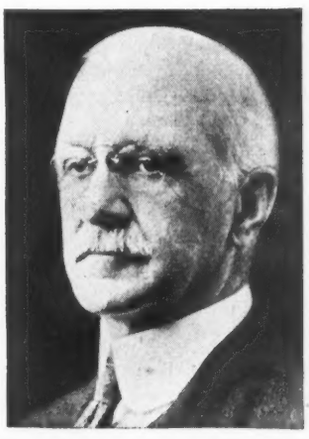
Joseph W. Roe
Melville Medal



William L. Emmet
A.S.M.E. Medal



Orville Wright
Guggenheim Medal



Fred J. Miller
Gantt Medal

Fifty Years of Progress in Power

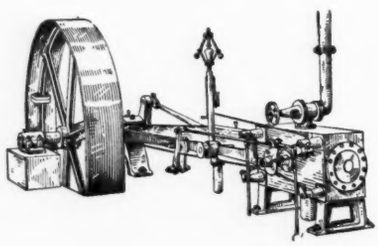
Along with the interesting events of the A.S.M.E. anniversary celebration, the April issue of *Mechanical Engineering* contains a remarkable presentation of articles summarizing the progress of science and industry in the last 50 years. Generation and use of power is represented by a section of 22 treatises of which F. R. Low is honorary editor.

FIFTY YEARS AGO, as Mr. Low points out in his foreword to this section, even the most advanced thinkers had no conception of the vast part power was to play in the far-reaching changes that were to come in almost every form of human activity. Yet it is inconceivable that such changes could have taken place without power. This is brought out most clearly in "Fifty Years of Power," the leading article in the series, by A. D. Blake and P. W. Swain. Here are set forth the enormous development and significance of power in man's progress.

Serving as a strong impetus to power development and touching a vast number of people directly in these striking changes has been the central station, whose advent and Aladdin-like growth occurred during the last half century. George A. Orrok, consulting engineer of New York, presents the phenomenal history of the public power plant in the second article, entitled "Central Stations." From Thomas Edison's Pearl Street station of 1882, Mr. Orrok traces the progress of central stations to present-day high-pressure, efficient plants of enormous capacity.

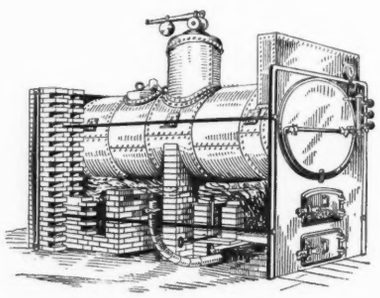
Reciprocating steam engines furnished the motive power for Edison's experiment, and they continued to hold sway until 1905, when they were supplanted by steam turbines.

The introduction of turbine-generators, writes Mr. Orrok, did not immediately improve the fuel economy of



the central station, since the water rate of the new type of prime mover was from two to three pounds higher than that of the best engine sets, but the savings in cylinder oil and labor, both operating and maintenance, were sufficient to show a commercial saving. The reintroduction of the superheater and larger condensers giving a better vacuum soon improved thermal conditions, and the convenience of the high speed and small floor-space requirements of turbines relegated large reciprocating machinery to a subordinate position. Sizes rapidly increased in the next few years, until in 1914 the last vertical Curtis machines of 20,000 kw. were installed, and both the Westinghouse and General Electric companies installed 30,000-kw. horizontal-type machines. By 1920 sizes had reached 50,000 kw., and they steadily grew to 160,000 in 1928 and 208,000 kw. in 1929.

The boiler participated in a similar enlargement and has increased in capacity from about 10,000 lb. of water evaporated per hour in 1880 in a single unit to 20,000 lb. in 1890, 60,000 lb. in 1910, 300,000 lb. in 1920, and 1,250,000 lb. in 1930. Stokers of the automatic type made their appearance before 1900, and came into general use before 1910. The chain-grate and overfeed



types were first introduced and developed, but the underfeed type came into wide use about 1910.

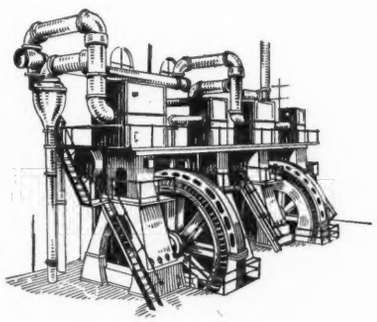
In 1920 the first large pulverized-fuel installation was put in service at Lakeside, Milwaukee, followed by many other large-sized pulverized-fuel stations. Pulverized fuel had been used in an experimental way since early in the 80's, but since 1920 about half of the large central stations have been built for pulverized-coal firing. About 1923, when both stokers and pulverized-coal firing had demonstrated the reasonable limits of heat liberation, the water-cooled furnace was introduced.

Standard steam pressures in 1880 varied between 75 and 125 lb. gage. In 1890 a pressure as high as 200 lb. was reached, which remained standard until about 1918, when higher pressures were tried, 300 lb. in 1918, 400 lb. in 1921, then 600 lb. in 1924, 1,200 lb. in 1925, and 1,600 lb. in 1929. Meanwhile, in Europe, Schmidt had gone to 1,800 lb. in 1918, and Benson to 3,200 lb. in 1924. Steam temperatures had been going through a different cycle. The first superheaters in 1902-1903 at best gave a temperature of 450 deg. F., but in the experiments ran to 650-700 deg., and since 1922, 750 deg. has been what might be called the maximum temperature.

With the improvements in design, increasing size, the use of condensers, and higher pressures and temperatures, the thermal efficiency of the central station has increased many times. Pearl Street used about 10 lb. of

coal per kilowatt-hour in 1883. This economy had improved to around 5 lb. by 1900, 4 lb. in 1910, 3 lb. in 1920, 1.7 lb. in 1928, and the 1930 figures will probably show about 1.5 lb. per kilowatt-hour as the average of central-station practice.

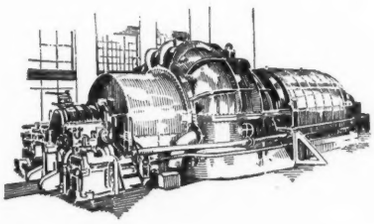
Following the history of central stations are two articles by Mr. Orrok, entitled "Fuel Utilization" and



"Carbonization of Coal," which show the development in the production and use of coal and other fuels for power. Albert C. Wood then carries the story forward with an article on "Industrial Power." Decade by decade, he traces the progress that has been made in the generation and application of steam and power in industrial establishments and in institutions of various kinds owning and operating plants for supplying their power requirements in whole or in part.

At the beginning of the decade 1880-1890, says Mr. Wood, the use of the steam engine in mills and factories had become general throughout the country, and mill owners no longer felt the necessity of developing near-by water powers. In some of the larger mills, the compound condensing engine had demonstrated its superior efficiency, and the corliss engine had gained great favor. With the development of dynamo-electric machinery came the high-speed automatic-cut-off engine. Boilers of the return-flue and return-tubular types with hand-fired grates probably represented the best practice in the art of steam generation during that time, notwithstanding the fact that several different kinds of water-tube boilers were in use, some of them being equipped with stokers of the overfeed or traveling-grate type.

From 1890 to 1900, corliss and high-speed engines were further improved, and direct-connected engine and

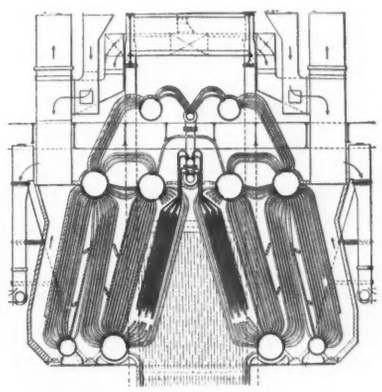


generator units largely displaced those using belts. Higher steam pressures came into general use, and by the end of the 1890-1900 decade, working pressures of 125 to 175 lb. gage were not uncommon in industrial plants. The manufacture and exploitation of the steam turbine was begun in this decade (in 1896), but no noteworthy progress was made in the introduction of this new type of prime mover in industrial plants. The same thing may be said about the polyphase alternating-current motor. Increasing interest was manifested in superheated steam, and superheaters were introduced, in a small way, in the closing years of the nineteenth century.

In the period from 1900 to 1910 the continuation of development work begun in the latter part of the previous decade resulted in the introduction and acceptance of the steam turbine, the polyphase, alternating-current motor, the underfeed stoker, the superheater, and other important additions and improvements in the power field. Engineers and plant owners were at first slow to adopt the new developments, and it was not until the latter half of the decade that real headway was made in their exploitation. Pulverized fuel was introduced in a small way, and Diesel engines made their appearance.

The trend of developments during the previous ten years continued in a normal way in the 1910-1920 decade until the outbreak of the World War, which upset all programs and calculations. The early part of 1920-1930, however, was followed by a period of reconstruction, rehabilitation and consolidation, in which great advances were made in power-plant engineering and in steam and power equipment of all kinds.

Many of the industrial plants which have continued in service have been enlarged or improved or entirely rebuilt, in accordance with the most modern thought and practice. In a number of cases where load con-

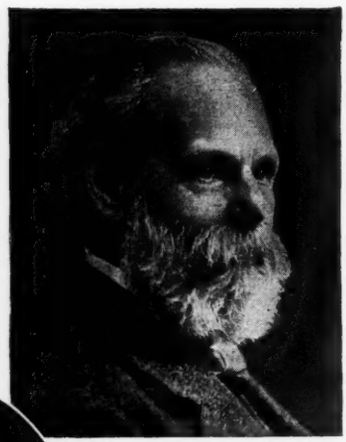


ditions have warranted the plants have been equipped with boilers built for 450 to 650 lb. working pressure, and steam temperatures as high as 700 to 750 deg. F. In a few installations the designers have ventured to working pressures of 1,200 to 1,800 lb.

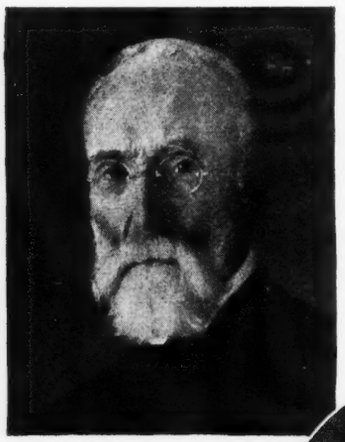
"Oil- and Gas-Engine Development," by L. H. Morrison, follows next in the series of articles on power. Mr. Morrison points out the fact that the introduction of the internal-combustion engine in the United States was practically coincident with the founding of the A.S.M.E. That it found a wide field of application soon after 1880 was due to its being modified to burn gasoline and to the need for an economical oil-pumping unit to take the place of the steam engine.

As far as can be learned, the first gasoline engine in this country was built by the Foos Gas Engine Company. A vertical single-cylinder gas engine was converted to the use of gasoline by the addition of a fuel pump whose stroke was under governor control, and of a tube projecting into the air suction pipe. After this initial attempt hundreds of machine shops and foundries began to build gasoline engines for application in localities where natural gas was not available. The first gas

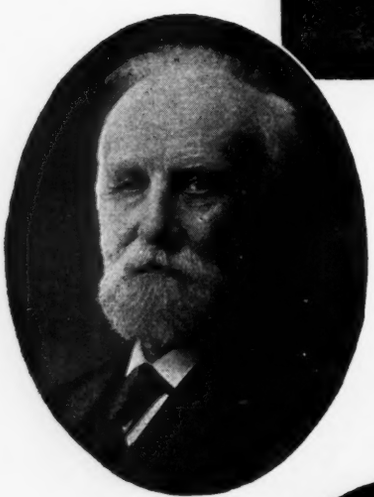
A.S.M.E. Presidents in Power's Field



R. H. THURSTON
1880-81
Teacher and Consultant

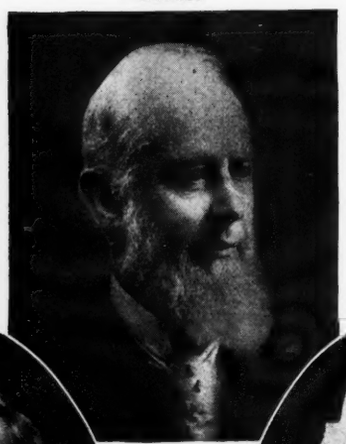


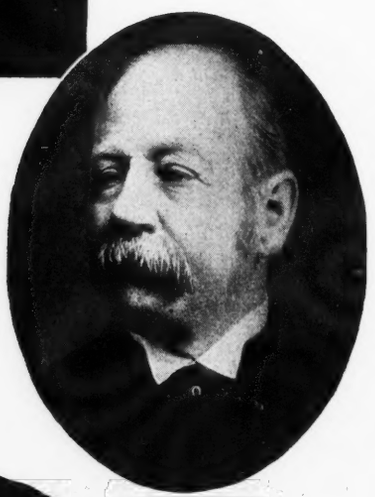
E. D. LEAVITT
1883
Pumping Engines



J. E. SWEET
1884
High-Speed Engines

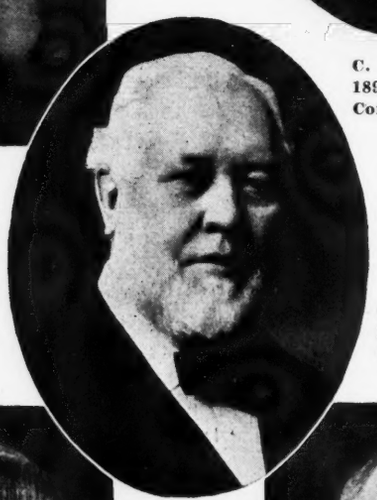
G. H. BABCOCK
1887
Boilers



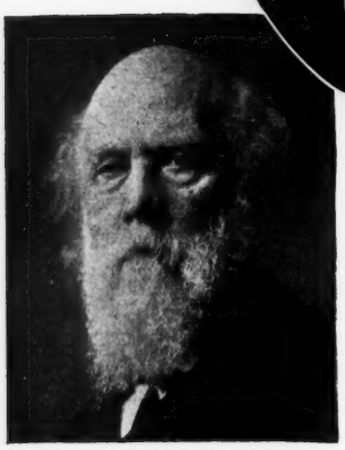


C. H. LORING
1892
Compound Engines

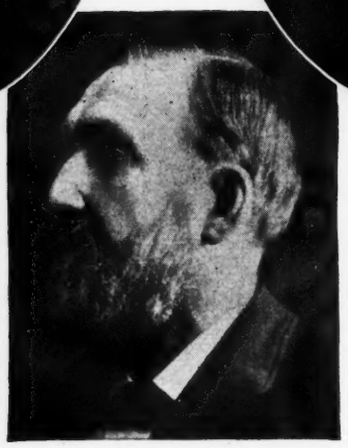
E. B. COXE
1893-94
Stokers



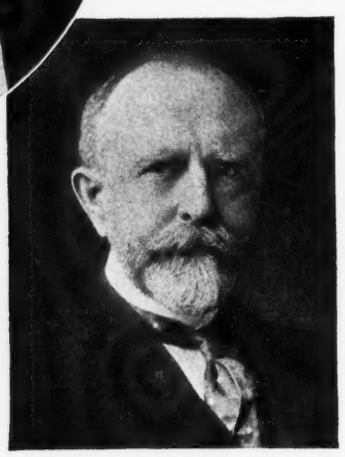
C. W. HUNT
1898
Coal Handling



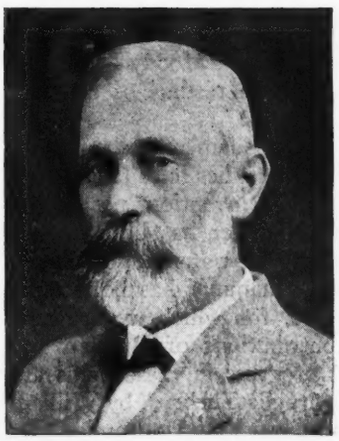
G. W. MELVILLE
1899
Chief Engineer, U. S. Navy



EDWIN REYNOLDS
1902
Engine Designer

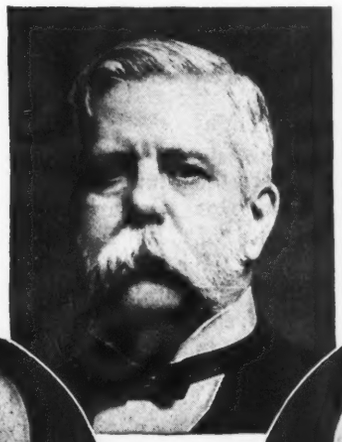


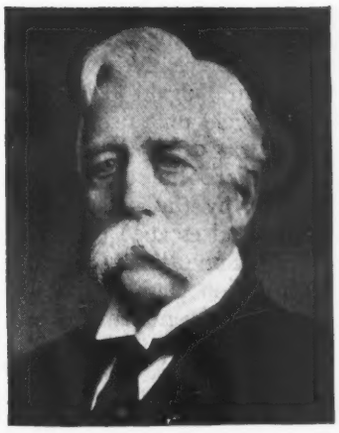
J. R. FREEMAN
1905
Hydraulic Engineer



M. L. HOLMAN
1908
Central Stations

GEORGE WESTINGHOUSE
1910
Electric Machinery





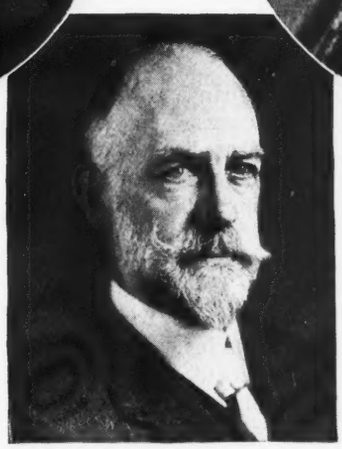
E. D. MEIER
1911
Boilers and Diesels

D. S. JACOBUS
1916
Boilers

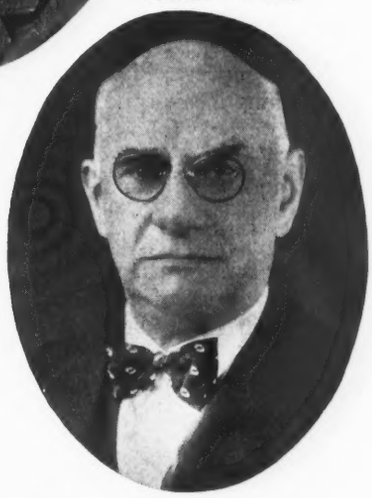
C. T. MAIN
1918
Consulting Engineer

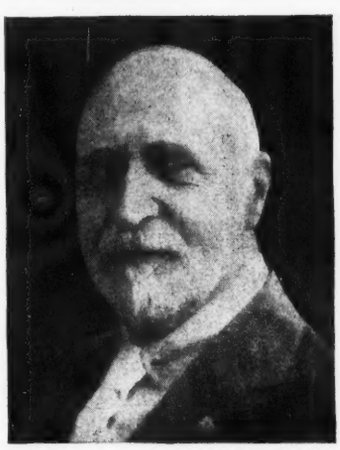
F. R. LOW
1924
Editor of *Power*

W. L. ABBOTT
1926
Central Stations



W. F. DURAND
1925
Hydraulic and Marine Engineer





ALEX. DOW
1928
Central Stations

E. A. SPERRY
1929
Inventor

CHARLES PIEZ
1930
Coal Handling

engine used commercially in the United States for oil-field pumping was one built by Joseph Reid, founder of the Joseph Reid Gas Engine Company, after the design of Dugald Clerk of England. This was a two-stroke-cycle unit using a separate charging cylinder in which was drawn and compressed the air and gas mixture before the charge was forced into the working cylinder by the pressure difference after the previous charge had escaped through the exhaust ports.

Next came the introduction of the oil engine. High-compression engines now built in the United States to which the given term "Diesel engines" is applied are the outcome of three parallel developments. One group of modern Diesels is derived from the original idea of Dr. Diesel; a second group traces its descent from the hot-bulb, two-stroke-cycle, low-compression oil engine originally introduced in America by the Mietz & Weiss Engine Company in 1895, and owing its existence to Charles Weiss. The third, the so-called "divided-combustion" engine, started with the low-compression, four-stroke-cycle Hornsby-Akroyd engine originated in England by Herbert Akroyd Stuart and introduced in America by the De LaVergne Machine Company in 1895.

Since that time the development of the oil engine has been rapid. The World War gave an impetus to the Diesel manufacturing, which, save for brief post-war depression, continued until in 1928, when there were 440,000 hp. of Diesel engines built in the United States, making the total installed since 1898, 2,260,000 hp.

Next in the series is an article on "Refrigeration," by John E. Starr. From the early use of natural ice for cooling and preserving food, Mr. Starr traces the progress of refrigeration through the machine-made ice period to modern, highly efficient equipment with many applications in air-conditioning and industrial processes.

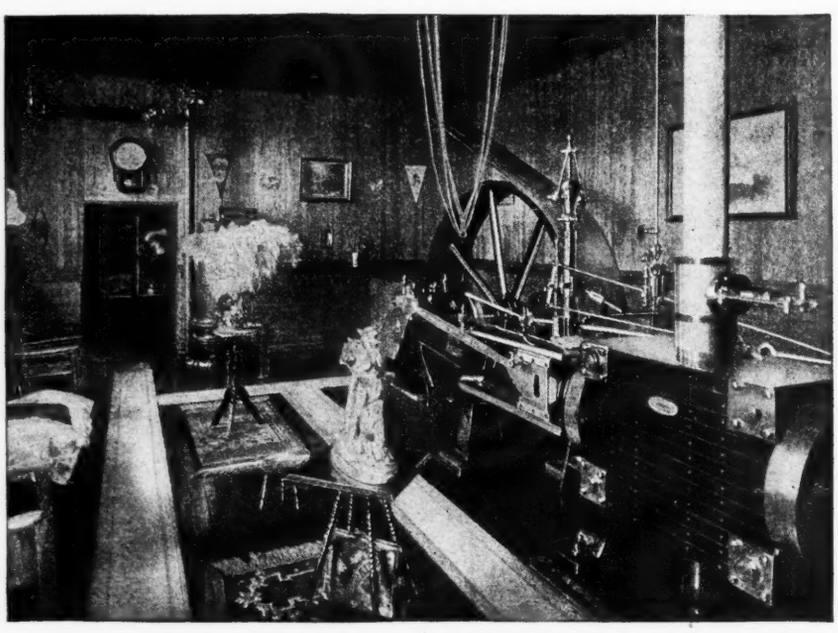
In the article following, entitled "Steam Generators," Hosea Webster shows how the development in the design and performance of steam-generating equipment during the last fifty years may be divided into three overlapping periods: hand-fired, stoker-fired and pulverized-coal fired, each of which he treats in detail.

The last part of the section on power is devoted to progress in hydraulics. It comprises fourteen articles dealing with theoretical hydraulics, water measurement, water-hammer, pumps, hydraulic turbines and hydro-electric developments by engineers well-informed in the various fields of hydraulic engineering. "Fifty Years' Progress in Hydraulics," by Lewis F. Moody and Blake R. Van Leer, heads the list, with a résumé of developments during the last half century.

The authors point out that fundamental changes in our conceptions of theoretical hydraulics have taken place during the last fifty years. The invention, perfection, and application of the Venturi meter has been one of the conspicuous accomplishments in water measurement. Our entire knowledge of water-hammer has been accumulated in the last fifty years, for which we are particularly indebted to the contributions of Russian and Italian engineers. Detailed progress in these fields are interestingly depicted in "Hydraulic Theory," by William F. Durand; "Advance in the Theory of Hydraulics," by Joseph N. Le Conte; "Fluid Metering," by Edward S. Smith, Jr.; "Gibson Method for Field Testing of Hydraulic Turbines," by Norman R. Gibson; "The Salt-Velocity Method of Water Measurement," by C. M. Allen; and "Development of Water-Hammer Theory and Its Applications," by Ray S. Quick.

In the pumping field, the fundamental principles of pumping by direct-acting pumps were fairly well established by 1880. Most of the improvements in this field have been brought about by increased knowledge and application of materials. The outstanding contribution in the last fifty years has been the remarkable development of the centrifugal pump. This has gone hand in hand with the development of high-speed electrical machinery. "Steam Piston Pumps," by A. M. Greene, Jr.; "Pumping Machinery," by R. L. Daugherty, and "Centrifugal Pumps," by A. Hollander, fully cover this progress.

The three types of hydraulic turbines—reaction, impulse and propeller—in their present embodiments are all creations of the last fifty years. Their efficiencies now exceed 90 per cent, and the magnitude of their outputs is impressive. That one hydraulic prime mover today can generate 84,000 hp. is a fact that even the most imaginative minds of 1880 would scarcely have predicted. The phenomenal history of these turbines is well described in "The Pelton Wheel," by E. M. Breed; "American Hydraulic Turbines," by William M. White; "Early Hydraulic-Turbine History," by Edward Dean Adams; "Hydro-Electric Engineering," by L. F. Harza.



Engine Room in the Gay Nineties

BENSON + LOEFFLER

Is It Practicable to Combine the Two Systems in One Unit?

By WILHELM FIRING

Mechanical Engineer
Oslo, Norway

LAST YEAR *Power* contained several interesting articles dealing with some of the better-known high-pressure steam generating systems, such as the Benson and the Loeffler, both developed in Germany.

Each of these systems has its admitted advantages and disadvantages. The Benson system is rather sensitive to feed-water impurities and requires much energy for the feed pumps, while the full pressure drop from the critical pressure (3200 lb.) cannot, it is understood, readily be utilized to advantage in power generating machinery.

The Loeffler system, on the other hand, should be particularly desirable as far as feed-water troubles are concerned, but it is surely a disadvantage to require a mechanical device to circulate steam under very high pressure in quantities several times exceeding the actual steam production.

It has occured to the writer that a combination of these two systems may offer a solution which, to a certain extent, eliminates the disadvantages of each.

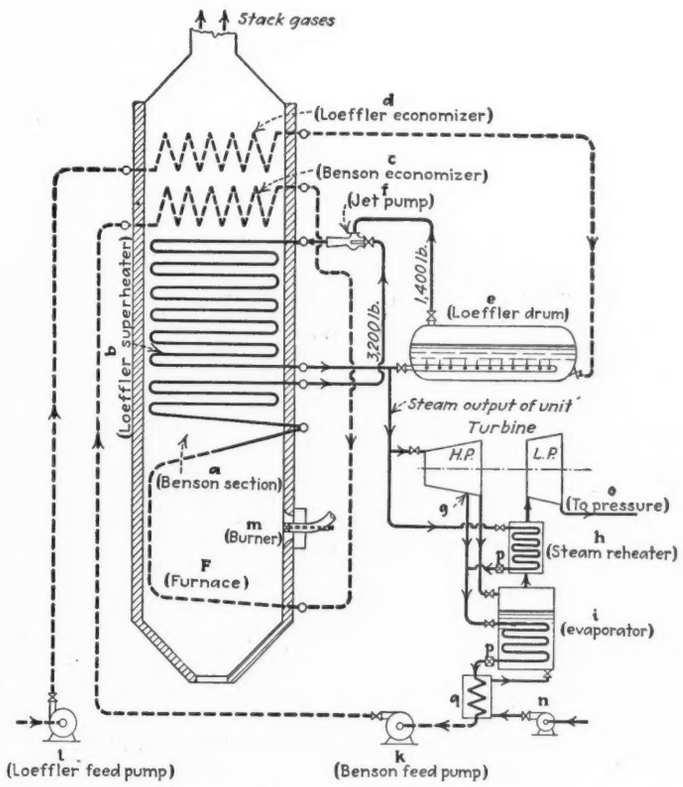
In the sketch a possible combination of the two systems is diagrammatically outlined. As an example, it is assumed that the plant is working with process steam expanding from, say, 1,420 lb. abs. to a suitable back pressure depending on the process, and that no condensate is returned. It is particularly under such circumstances (back-pressure operation) that very high initial pressures like this are most desirable.

It will be noted that the furnace *F* supplies heat for two separate tube systems arranged in series. The one especially adopted to absorbing the radiant heat is marked *a*, and constitutes the Benson section. Here water is forced through at critical pressure by means of the pump *k* feeding the system via an economizer *c*. After the water has been heated to 687 deg. F. it turns into steam in a body and is then superheated before it passes on to a jet pump *f*, the object of which will be explained.

The "Loeffler" part of the plant consists of the drum *e*, to which water is fed at approximately 1,400 lb. by the pump *l* via an economizer *d*. The steam from the drum, in accordance with the Loeffler principle, is circulated through the superheater *b*, where it is highly superheated. Part of it is led to the high-pressure turbine, and that amount constitutes the steam output of the unit. Most of the steam from the superheater is, however, led back into the drum, where it gives up its superheat to the water and generates steam.

The idea put forward in this article is that the energy required for this circulation of steam from the drum through the superheater and back again to the drum is to be provided by steam from the Benson part of the system in connection with its expansion from the critical pressure down to that of the Loeffler section (here assumed to be 1,400 lb). Moreover, this work is to be done by means of a jet pump, that is, without any mechanical device involving moving parts.

To obtain the pure feed water necessary for the Benson section, a steam transformer is generally applied, indicated in the sketch. The steam from the high-pressure turbine is partly bled, at *g*, to an evaporator *i*, and is there condensed to make up feed water for the Benson section, while the new steam generated in this process is mixed with the remaining exhaust



THIS IS WORTH LOOKING INTO—*Editor*

from the high-pressure turbine and heated in the reheater *h* before passing on to the low-pressure turbine, which, in turn, exhausts into the process-steam header *o*.

I shall now consider what advantages seem to be derived from the arrangement here outlined, compared with each of the systems of which it is made up.

Compared with the Benson system, it is evident that the combined boiler saves pump work, as only a fraction of the total steam is generated at the critical pressure. Further, the steam transformer, which is a big item in such a plant, can be made very much smaller than is the case in an ordinary Benson plant, in which all the steam from the high-pressure turbine must be transformed and the turbine must exhaust at the point *g;* whereas, in this case, only part of the steam is bled.

The Loeffler section is really the main part of the proposed combination. The advantage of this combination compared with the straight Loeffler is mainly the omission of the usual steam circulating pump. There is, however, another point worth mentioning, namely that the superheater, being the primary heat-absorbing element in a Loeffler boiler and therefore generally subjected to radiant heat, is, in the case of the combined boiler, preceded by water-cooled surface, that is, by the Benson part. This tends to spare the superheater, or it allows lower steam velocity and pressure drop.

It is of interest to ascertain how much steam must be generated at the critical pressure to supply enough energy for the circulation of steam at the lower pressure (1,400 lb.) In other words, what is the ratio of the steam outputs of the Benson and the Loeffler sections of this combination?

As an example, it is assumed that steam from the drum *e* enters the jet pump at 1,400 lb. in a dry state. It is further assumed that the design of the superheater and circulation system is, in general, such that the pressure at the outlet of the jet pump must be raised by 25 lb. to keep up the desired circulation. Finally, it is assumed that the steam leaves the tube section *a*, as well as *b*, at a temperature of 887 degrees Fahrenheit.

Using the Mollier diagram and assuming the thermodynamic efficiency of the jet pump to be 25 per cent, it will be found that about one-third of the total steam output of the unit has to be generated in the Benson section at the critical pressure.

The writer has no personal experience with either the Benson or the Loeffler boilers, but, judging from what has been published pro and con of these systems, a combination such as outlined appears to have some points to recommend it.

It would be interesting to hear the opinion of engineers who have had experience with the systems concerned.

[Discussion of Mr. Firing's very interesting proposal is invited—Editor.]

▼ ▼ ▼

If Orsat Checks Normal

But Electric Co_2 Meter Seems Erratic

Look for Waste

WHEN combustion conditions are normal, flue gas contains carbon dioxide, nitrogen, oxygen, and possibly slight traces of carbon monoxide. Carbon dioxide has a thermal conductivity about 0.6 of that of air. The other constituents have about the same thermal conductivity as air, and it is for this reason that the cell utilizing this property will generally agree with the Orsat as an analyzer of the carbon dioxide in flue gas.

A recent study of combustion conditions during which numerous tests were made with various gas-analyzing equipments has definitely shown that it is possible to have not only CO in the flue gas as an unburned combustible, but also free hydrogen and other unburned hydrocarbons. These tests, made by the Brown Instrument Company, have also shown that the presence of free hydrogen in flue gas is more common than is generally supposed.

In the burning of natural gas, for example, it has been proved that flue gases at times may contain unburned hydrogen, carbon monoxide, and methane, although in the particular instance where this was observed these gases were well above their ignition temperatures. Such conditions were the result of improper mixing of the gas and the air before combustion occurred, and a certain amount of the gas succeeded in passing through the combustion chamber without being intimately enough in contact with the oxygen to burn completely. As a consequence, the gas which did not come in contact with the oxygen was presumably "cracked," and liberated hydrogen and carbon monoxide.

Hydrogen is frequently found in the flue gas of a coal-fired boiler when the coal is wet, particularly after a heavy charge of fresh wet coal has been added to the furnace. The steam which surrounds the surface of the small particles of coal tends to exclude oxygen, and as a result both carbon monoxide and hydrogen are produced, much the same as in a water-gas set.

It is possible, by various methods, to treat the flue gas to eliminate certain products of incomplete combustion before passing the gas through the thermal-conductivity cell. Flue gas containing free hydrogen, for example, may be passed over copper oxide heated to a temperature sufficiently high to convert the hydrogen into water. A sample of gas so treated will contain nitrogen, carbon dioxide, and oxygen, and an anlysis with the Orsat will indicate the same percentage CO_2 as will be shown by a thermal-conductivity cell.

There are several reasons for questioning the advisability of removing these abnormal products of combustion for the sole purpose of having the thermal-conductivity cell agree with the Orsat. Since the effect of hydrogen on any thermal-conductivity cell is comparatively large, a small amount of hydrogen will have a very noticeable effect on the reading of an electric CO_2 meter.

One per cent of hydrogen, for example, will completely neutralize the effect of approximately 12 per cent CO_2 and the resultant reading will be zero. The erratic behavior of the cell under such conditions is quite noticeable and appears to be a reliable indication that combustion is abnormal.

Thus erratic indications from the electric CO_2 meter may often prove to be of unexpected benefit.

ELEVATOR SIGNAL SYSTEMS *Using* Flashlight Annunciators

By F. A. ANNETT
Associate Editor, *Power*

How an elevator signal system operates using flashlight annunciators with automatic signal reset

NO MATTER how good an elevator machine may be, satisfactory service cannot be rendered without an adequate signal system. A signal system must provide a means of informing the operator in the car where the waiting passengers are. It should also indicate to the waiting passengers when a car is approaching the floor and the direction in which it is going. The more complete this information the more satisfactory the elevator service.

Unless the operator has advance information on the location of the passengers, cars will be run by floors and passengers left waiting. Such occurrences are one of the chief causes of complaint against elevator service. On the other hand, unless waiting passengers on floors have advance knowledge of approaching cars, they may not see the car that stops at the floor or the operator may have to wait and call to attract passengers' attention. Even though passengers may see the car at the floor they may not know which direction it is going and will delay the car until they can find out from the operator. All this slows up elevator service and reduces the efficiency with which passengers are handled.

What constitutes an adequate signal system depends upon many conditions. It varies from a simple drop-type annunciator system to a signal system that is a part of the elevator control system and the cars stop automatically in answer to floor buttons pushed by waiting passengers.

In this article one of the simple systems using flashlight annunciators will be described. A wiring diagram of a system manufactured by the Elevator Supplies Company, Inc., is shown in Fig. 3. When a waiting passenger pushes a button to signal the operator a light is energized in an annunciator on each of the cars. These lights remain in circuit until a car has gone by the floor in the direction indicated by the signal, when the signal is removed from the annunciators automatically.

For each floor there is an up and a down relay except for the terminal floors, which have one relay each. One of these relays is shown on the right in Fig. 3, with two coils *A* and *B* and a mercury contact pot *M*. Coil *A* is connected to a floor button, and *B* to the reset machine. When coil *A* is energized by a passenger pressing a floor call button it attracts its armature *C* and releases armature *D*, which falls by gravity and makes contact in the mercury pot *M*. In this operation the right-hand end of armature *D* rises and locks *C* in the closed posi-

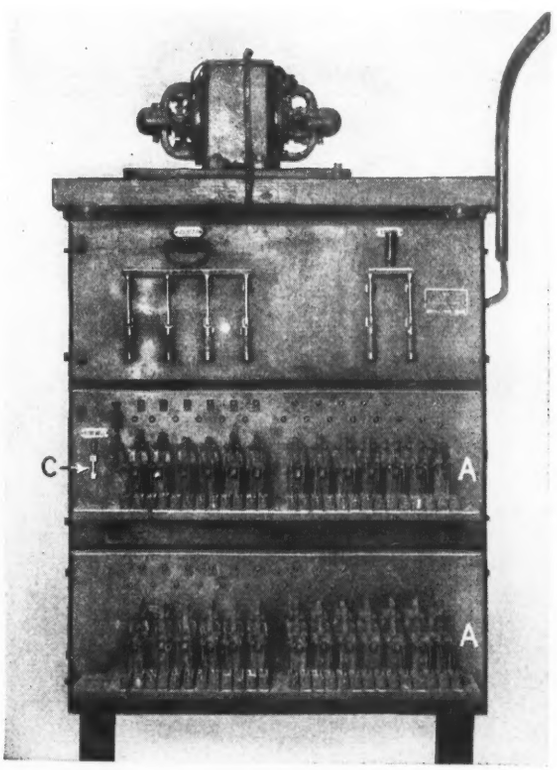


Fig. 2—(Above) Relay panel for elevator signals in a 14-story building

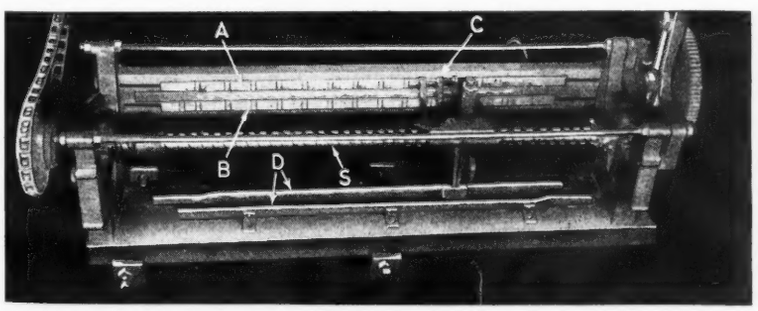


Fig. 1—(Left) Machine for automatically resetting the signal after the floor calls have been answered

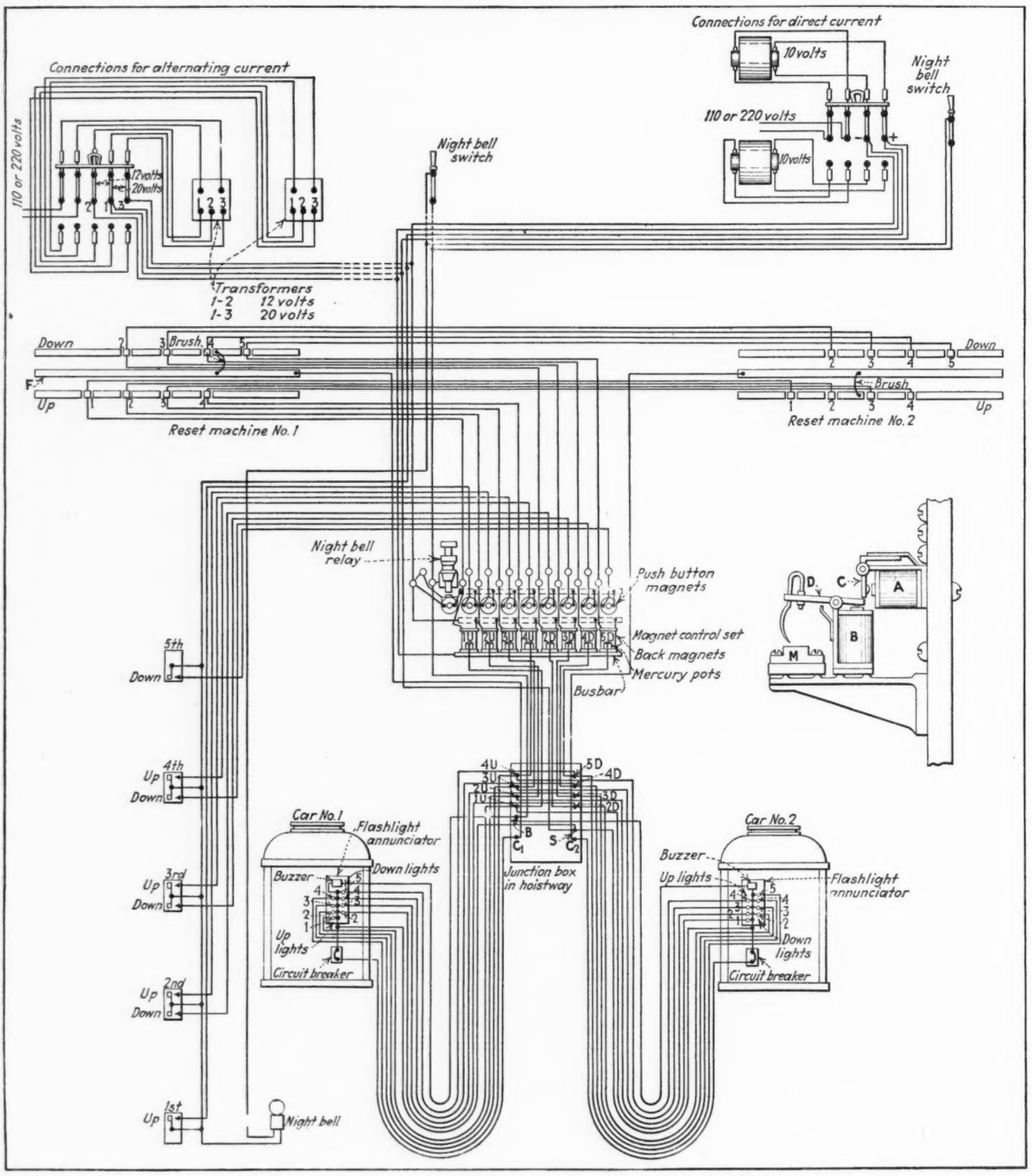
tion, where it remains until coil *B* is energized. When armature *D* makes contact in the mercury pot it completes a circuit for the light annunciators in the cars to indicate the floor to the operators. The lights remain energized until the operator leaves the floor from which the signal was given and in the direction indicated.

If a signal is given for a car to stop at a certain floor in the down direction, the first car that goes about three feet below this floor makes a contact in a reset machine that energizes coil *B* in the relay. The magnet attracts armature *D* and releases *C*, which takes the position shown in the figure and retains the contact out of the mercury pot, thus removing the signal from the annunciators in the cars.

The reset machine consists of two rows of contacts, *A* and *B*, Fig. 1; one for the up and the other for the down signals. Brushes *C* are moved over each set of contacts. When the car is in down motion the brushes are in contact with the down contacts only. On up motion the brushes shift from the down to the up contacts. By this arrangement signals are reset in the direction only in which the car is going.

The reset machine is driven by a sprocket chain from the end of the drum shaft. The brushes are carried on a screw shaft *S*. On this shaft the sprocket has a clutch that slips to compensate for slippage of the cables on traction elevator machines. If the cables slip and throw

Fig. 3—Wiring diagram for a flashlight annunciator signal system with automatic reset



the reset machine out of adjustment, the screw shaft runs against a stop before the car reaches a terminal landing and is prevented from turning. For the remaining travel of the car to the terminal, the clutch in the screw shaft slips. In this operation the brushes are brought into correct adjustment. The brush carriage rides directly on the driving screw and is prevented from turning with the screw by stops *D*. These stops are set so that when the direction of the screw is reversed the brush carriage is moved far enough in the screw's direction of rotation to transfer the brushes from one row of contacts to the other.

Only one bank of relays is required regardless of the number of cars, but a reset machine is needed for each car. When a floor call button is pressed it registers a signal on the annunciator of all cars. The reset machine on the first car answering the call removes the signal from the annunciator in all the cars. Thus the operators are kept informed of the calls to be answered.

Fig. 2 shows a relay panel for a 14-story building. The relays in the lower bank *A* are for one direction and those in the upper bank are for opposite direction of travel. The small switch *C* is for the night bell in the hoistway. At the top of the panel is the 220- to 10-volt motor-generator for supplying power to the signal system. The 2-pole switch on the right is on the lights in the floor lanterns and the 4-pole switch controls the car signal circuits.

A STUDY of the diagram, Fig. 3, will make the foregoing discussion clearer. Either 10-volt direct current or 12- and 20-volt alternating current may be used. In either case two devices are usually provided to supply the power and are connected with a double-throw switch so that either one may be used on the system. Assume that the power supply is direct current, then two motor-generator sets are provided to convert the 110- or 220-volt direct current into a 10-volt supply.

If a waiting passenger on the fourth floor presses the down button a circuit is formed from the + side of the power switch to the common connection between the two buttons on the fourth floor. From here the circuit continues through the down button, the push-button magnet on the 4*D* mercury pot, the night-bell relay coil and to the — side of the power switch.

Energizing the push-button magnet releases the contact and it drops into the mercury pot to complete a circuit for the fourth floor down signal light in the cars' annunciators. This circuit is from the + side of the switch to the S-connection in the hoistway junction box. From the junction box a conductor goes to the common connection between the up and the down signal lights in the annunciators of all cars. The circuit is then through No. 4 down lights back to the 4*D* terminal in the hoistway junction box, the 4*D* mercury pot, the busbar under this pot and to the — side of the line. The same circuit is energized to the annunciators in all the cars and the fourth floor down signals are set. In this way each operator knows where the passengers are waiting.

There is a buzzer at the top of each annunciator that may be used if desired to give the operators an audible signal. The circuit for the buzzer is from between the signal lights to the *B* terminal in the hoistway junction box through the contacts of the night-bell relay and to the — side of the line. The night-bell relay contacts are closed when a floor button is pressed, consequently the buzzer will ring only while the button is held closed.

Sometimes a night bell is installed in the elevator hoistway to call the attention of the night watchman, who may also be operating the elevator. This bell circuit is controlled by a single-pole knife switch on the signal system in the elevator room. When the night-bell switch is closed, as in the figure, pressing any of the floor buttons will ring the bell and give a signal on the car annunciator. The circuit for the night bell is from the common wire for the floor push button through the bell's coil, the night-bell switch, the night-bell relay contacts and to the — side of the line. The night-bell relay contacts are closed only while a push button is pressed, therefore the bell will ring only when a button is closed.

The circuits for the other floor signals can be traced as explained for the fourth floor down call. When a floor button has been pressed and a signal set on the annunciators it remains until a car has gone to the floor in the direction of the call. When a car is a short distance past that floor a contact is made in the reset machine that energizes the mercury pot magnet and opens the contact corresponding to the floor and the direction in which the car is going.

Assume that No. 1 car answers the fourth floor down call: The circuit for the reset magnet is from the common connection between the annunciator lights through the circuit breaker to the C_1 terminal in the hoistway junction box to the busbar *F* in No. 1 reset machine. With No. 1 car in down motion, the brush in the reset machine makes contact between the down row of contacts and busbar. This brush will move from right to left as the car travels downward. When the car is a short distance below the fourth floor the brush in the reset machine comes on to contact 4 and completes the circuit from this contact through coil 4*D* on the mercury pots and to the negative side of the line.

Energizing coil 4*D* causes it to lift the contact out of the mercury pot, and the No. 4 down signal lamps on the annunciators go dark. This shows the operator on No. 2 car that the down call on the fourth floor has been answered.

The circuit breaker in each car is a push button that allows a car to pass a floor without resetting the signals. For example, if No. 1 car left the top floor with a full load and did not stop to answer the call from the fourth floor, pressing the circuit-breaker button would hold the reset circuit open and the signals would remain on the annunciators of the following cars.

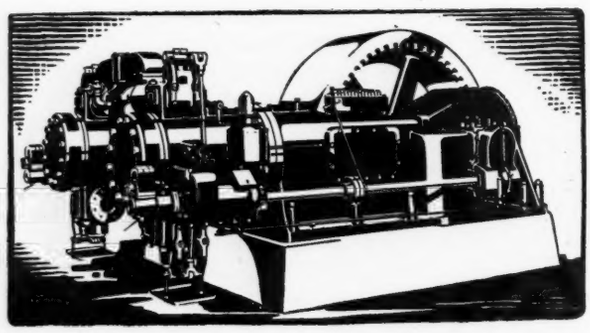
In the diagram, down contacts 2, 3, 4 and 5 on reset machine No. 1 are connected to down contacts of the same number in reset machine No. 2. Cross connecting the machines allows either to reset signals, depending upon which elevator answers the call.

WHEN alternating current is used, 12 volts is supplied for the lamps, as from poles 1 and 2 of the switch, on the left, and 20 volts is used on the magnet coils across poles 1 and 3. On account of the magnet coils' inductance, about double the voltage is required to operate them on alternating current as on direct current. The inductance of the light circuits is low, and only a slightly higher voltage is required than for direct current.

Signal systems of this kind are used for groups of one or more elevators in buildings, such as hotels or office structures, where the service may be intermittent and the elevators do not always make complete trips. Where the elevators are intended to make complete trips, an operator's signal-light system is frequently used. This will be the subject of another article.

VARIABLE SPECIFIC HEATS

In Gas Engine Calculations



By WM. J. WALKER

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Dr. Walker is well known for his work on internal-combustion engines while at Victoria College, University of Manchester, England, and at Dundee University, Scotland. His point of view will be interesting even if the reader is unable to assent to the major premise.

THERE appears to be a widespread impression among engineers and internal-combustion engine experts and designers in practically all countries that the laying down of any specific method of design or technical testing of internal-combustion engines based on variable specific heat data of fixed characteristics is impossible. This opinion appears to be due to the frequently repeated statement that no such fixed characteristics can be ascribed to the different types of fuel used or to the varying mixture strengths employed. However, this assumption is entirely erroneous, as will be shown.

The writer has been responsible for several methods and charts proposed for design and test purposes, but until recently had never been successful in evolving a method that rendered any extensive investigation possible while at the same time taking into account variations in the initial temperature and pressure conditions at the beginning of compression. While the present article has nothing to do with these initial compression pressure and temperature conditions, the new method recently evolved made it easily possible to investigate the effect of variation in the fixed characteristics of variable specific heat equations.

To illustrate the wide variation in these characteristics as proposed by different authorities the following six combined equations for specific heats were chosen for the purpose of the investigation:

Wimperis:

$$K_V = 212.8 + 0.105\,T$$
$$K_P = 308.8 + 0.105\,T$$

Clerk:

$$K_V = 245 + 0.0714\,T$$
$$K_P = 341 + 0.0714\,T$$

Pier and Bjerrum:

$$K_V = 220 + 0.0693\,T$$
$$K_P = 316 + 0.0693\,T$$

Langen:

$$K_V = 217 + 0.0575\,T$$
$$K_P = 313 + 0.0575\,T$$

David:

$$K_V = 233 + 0.07\,T$$
$$K_P = 329 + 0.07\,T$$

Walker:

$$K_V = 220 + 0.0623\,T$$
$$K_P = 316 + 0.0623\,T$$

The units in which these equations are expressed are foot-pounds per pound per degree Centigrade. The equations are of the general linear type of $K_V = B + ST$ and $K_P = A + ST$

with $$m = \frac{A}{B}$$

and $$\lambda = \frac{S}{B}$$

The following table gives the values of m and λ for each of the equations:

	m	λ
Wimperis	1.452	0.0004935
Clerk	1.392	0.0002914
Pier & Bjerrum	1.436	0.000315
Langen	1.442	0.000265
David	1.412	0.0003
Walker	1.436	0.000283

Since efficiency values depend both upon m and on λ and since the variations of these in the above table are approximately 4 and 75 per cent, respectively, it is clear

that while preference may be given to some particular method of design or analysis or to the use of some particular type of chart, no finality can be reached until there is general agreement upon the values of the constants m and λ.

A somewhat analagous state of affairs existed in the earlier days of internal combustion engineering, when much dispute arose regarding the most suitable value for R in the general equation $PV = RT$ for gases. Later, however, it was demonstrated by several authorities that the presence of carbon dioxide and steam in the burnt gases had practically no effect in altering the value of R from that of pure air. It is my object to show that changes in the value of λ between certain limits, which are wide enough to render the settlement of its value a relatively easy matter, has practically no effect upon the thermal efficiency value obtained.

To broaden the basis of the investigation, three separate cases were considered, as follows:

Case 1—Petrol engine with a compression ratio of 6 to 1, and initial compression temperature and pressure conditions of 350 deg. C. abs., and 14 lb. per square inch absolute.

Case 2—Airless injection cold-starting, crude-oil engine with a compression ratio of 8 and a maximum combustion pressure of 700 lb. per square inch absolute. Initial compression temperature and pressure as in Case 1.

Case 3—Diesel engine with a compression ratio of 14 and initial compression temperature and pressure as in Cases 1 and 2.

In all three cases the heat supply was the same and equal to 0.667×10^6 ft.-lb. per pound of working fluid.

The efficiency results for each of these three cases are shown below:

Formula	Efficiency, Per Cent Case 1	Case 2	Case 3
Wimperis	39.7	44.1	44.5
Clerk	39.5	46.1	46.1
Pier and Bjerrum	41.1	45.7	45.7
Langen	43.2	48.9	48.9
David	41.2	45.9	45.9
Walker	42.3	46.6	46.6

The greatest variation in efficiency that occurs between any two examples in any of these cases is in Case 1 and represents a difference of but 8 per cent, against a 75 per cent difference in the value of λ. In the other two cases the greatest difference amounts to only 6 per cent. Before discussing these results, however, one or two other points require consideration.

The formation of equations of the form $K_V = B + ST$ and $K_P = A + ST$ has no other object than an empirical one. Such equations have no pretensions to any conformity or otherwise to thermodynamic requirements. They are, indeed, independent of such requirements. They may possess a semblance of falling in with Maxwell's equipartition hypothesis in the "Kinetic Theory of Gases," but beyond that they are equations which rely mainly upon the usefulness of their application to practical purposes, together with an approximate agreement with experimental results. Nevertheless they should conform to the accepted value of $A - B = R = 96$ and to a value of $m = \gamma = 1.4$, when $T = 15$ deg. C., or 288 deg. C. abs. A study of the examples given in the foregoing, will show that the value of γ varies appreciably among them.

Bearing these facts in mind and noting that if the efficiency results obtained by the use of Wimperis' and Langen's formulas be deleted as being on the one hand too low and on the other too high, it will be seen that the remaining results agree within 2 per cent among themselves in spite of a variation in the value of λ of as much as 11 per cent.

In face of these facts it is surely a needless waste of time to argue what the value of the empirical factor λ should be. To conform to the requirements of the equations $K_V = B + ST$ and $K_P = A + ST$.

As already indicated, the writer has adopted the general values

$$K_V = 224 + 0.0672\,T$$
$$\text{and} \quad K_P = 320 + 0.0672\,T,$$

giving a value to λ of 0.0003 and to m of 1.43, round figures which are useful and sufficiently accurate for all practical purposes.

It is evident from the foregoing that the argument that one should allow for the mixture strength in making efficiency calculations is in line with the old contention that the value of R is affected appreciably by mixture strength. Hence, there has been seen in the technical press, within the last ten years, many laborious step-by-step calculations made with the object of showing that the use of different fuels and of different mixture strengths require separate treatment in efficiency calculations. In none of these cases within the writer's knowledge has any result been given that justifies that contention or that carries any conviction, unless it may have been obtained by the use of very doubtful and uncertain data relating to dissociation effects. The thermodynamic method of analysis, involving the factor λ, as developed by the writer and given in previous papers, is the most expeditious method available for rapid design and test calculations with any approximation to accuracy. And, as shown by the foregoing, the question of what the value of λ should be, ought easily to be settled once for all in the interests of uniformity.

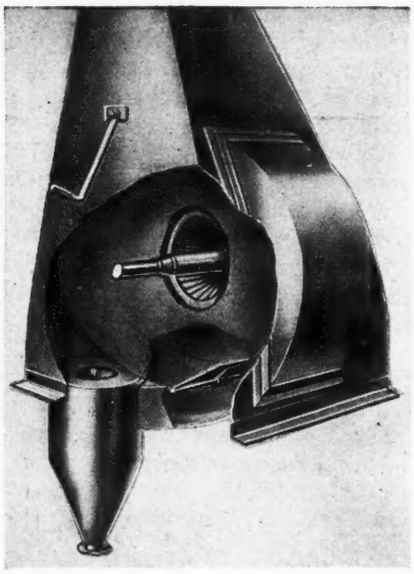
▼ ▼ ▼

"Electrolene" is the trade name of the gaseous mixture that issues from the generator here shown. The raw materials are steam, electricity and ordinary city or natural gas. "Electrolene" consists chiefly of carbon monoxide, hydrogen and carbon dioxide. Within wide limits the automatic controls of steam and electricity can be set to give any desired proportions of these constituents as required for industrial purposes. More complete information is given in the April number of the *General Electric Review*.

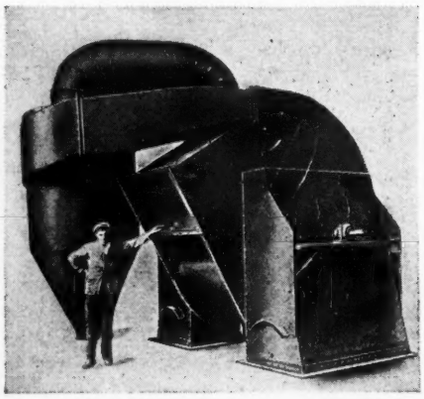
DUST COLLECTION

Steps in the development of one type of mechanical separation

By LOUIS C. WHITON, JR.[1]



Fan and dust collector with section cut away



Bypass duct leading from fan scroll

A STUDY of existing methods of dust collection led to the conclusion that the following factors should guide in devising a type of apparatus to suit the greatest number of cases: (*a*) There should be a high percentage collection of the dust in the gases, with particular reference to the extremely fine material; (*b*) the apparatus should occupy a minimum of space; (*c*) it should utilize as little power as possible; (*d*) it should have flexibility to meet varying load and emergency conditions; (*e*) if possible, it should utilize such existing conditions as are favorable to dust collection. Mechanical separation was decided upon.

The principle of mechanical separation is based upon utilizing the difference in the specific gravity of the particles carried in the gas and that of the gas itself, the particles dropping by their own weight into a settling chamber, being separated by centrifugal force, or arrested by baffles.

The settling chamber is a simple apparatus, in which the gas velocity is greatly reduced, thus permitting the dust particles to settle and the gas to pass out of the chamber. It generally requires considerable space for efficient precipitation, for, according to Stokes Law[2], gas moving vertically and uniformly permits fine ash, for example, to drop in the neighborhood of $2\frac{1}{2}$ in. per second. Nevertheless, where space is available it is an economic method of precipitation, as there is practically no absorption of energy for its operation.

Use of baffles is based upon the inertia of the dust particles which are projected out of the current of gas. The degree of elimination depends upon the momentum of the particles and their size. It is evident that the larger, denser particles will have less tendency to again be accelerated by the gas stream than the lighter particles. With sufficient space and enough baffles an efficient cleaning can be obtained, provided a velocity can be maintained so that the gas strikes each baffle with enough force and at the same time does not increase the resistance to its passage beyond a reasonable point.

Employment of centrifugal force makes it possible to eliminate the heavier material at a much greater speed than when by relying upon gravity.

Considerations of initial cost, space involved, quantities of water needed and power requirements of several existing types of precipitation equipment led to an investigation of smaller apparatus based upon the principle of centrifugal precipitation. It was observed that in the involute of the fan, the gas was already passing in a circular path and centrifugal precipitation could be applied without occupying more space than would be required normally by the induced-draft fan.

Directions followed by the gas in a fan are as follows: It enters the wheel parallel with the shaft, makes an abrupt right-angle turn, and issues from the edge of the blades, where it is projected at high speed into the involute. The right-angle turn has a tendency to concentrate the dust along the central circular plate of a double-inlet fan or along the back plate of a single-inlet fan. The next point of concentration will be along the outer race of the involute.

The first apparatus built to determine the method of utilizing these forces had a hopper beneath the involute. This contained slots, so that the dust would be thrown

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[2]Stokes Law is expressed in metric units by the following:

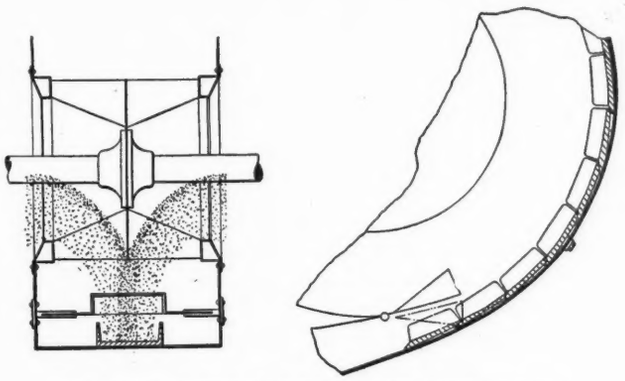
$F = 6\pi rkv$, where F is the resistance of the fluid; r the radius of particle assumed to be spherical; k the coefficient of viscosity of the fluid; and v the speed of the particle in relation to that of the fluid. The coefficient of viscosity is generally given in C.G.S. units. Its value for air is 1714×10^{-7} at 0 deg. C.; 2113×10^{-7} at 100 deg. C.; and 2476×10^{-7} at 200 deg. C.

out and the gas pass to the fan outlet. It was soon observed that this did not collect a sufficient quantity of dust, as there was practically no current of gas into the hopper and the eddy currents that were set up, due to the slots, prevented high elimination of extremely fine particles. This method appeared satisfactory for heavy particles, but not for 300-mesh material.

NEXT, the length of the involute was increased, so as to make two turns instead of one about the fan wheel and thus give the dust greater apportunity to concentrate in the fan casing. This was an improvement over the first experimental unit, but elimination of the fine material was still insufficient.

This indicated that the inertia of the dust particles, causing them to be projected through the openings in the fan casing, was not enough to produce the desired results. It was therefore suggested than an actual current of gas, carrying the concentrated material, be set up. The concentrated material could then be eliminated from this comparatively small quantity of gas and the cleaned gas returned to the inlet. An additional advantage was that the efficiency of the outside precipitator was not of such importance, since the fan precipitator had another opportunity to precipitate any dust that escaped the outside collector.

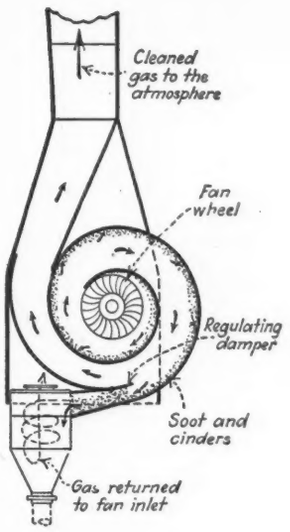
The greater the quantity of gas withdrawn the higher was the dust elimination efficiency but the lower the mechanical fan efficiency. It finally was determined that



Trajectory of dust after entering fan blades at right, cast-iron wearing plates with guides in fan scroll

sufficiently high dust elimination was obtained by recirculating 10 to 15 per cent of the gas. This increased the quantity of gas handled, and in consequence the power consumption. Next, it was necessary to determine what effect the relative section of gas stream cut into by the bypass damper had upon dust removal. The efficiency of dust collection was found to increase as the "slice" of gas increased, the quantity recirculated remaining the same; but the greater the "slice" the greater the resistance encountered at this point of the involute.

It was found that for a given dust elimination the character of the material, its specific gravity and its relative fineness determined the size of this opening. Experiments were conducted upon various grades of pulverized-coal ash, cement, lead products, wood refuse from boilers and even extremely light materials such as wood shavings. Undoubtedly, the most important product examined was pulverized-fuel ash, and the observations were concentrated on this. Ash from many power plants was tried, concentrations ranging from 1 to 30 grains per cubic foot.



Principle of dust collector combined with fan and stack

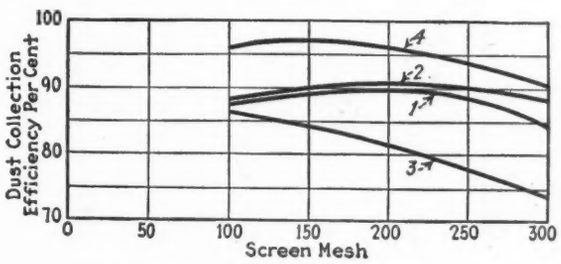
By introducing a given weight of material which had already been subjected to a screen test, it was found that accurate results could be obtained as to the relative efficiency of the apparatus on various mesh materials. In other words, with a charge of 100 lb. of mixed materials containing 60 lb. of dust passing through 300 mesh and a total collection of 92 lb. the collected material could be analyzed and thus the efficiency of the apparatus determined for each classification of fineness of dust.

The curves here shown indicate the efficiency as depending upon the fineness of the dust and the mechanical efficiency as a function of the per cent of gas withdrawn from the total gas stream within the fan involute.

The earlier test was run with air, and although the specific weight of the gas is somewhat greater than air, it was found that results checked closely.

IT IS NATURAL that any mechanical device to collect dust will be eroded to an extent depending upon the nature of the dust, and it became necessary to study the problems of building the fan and wheel of material which would withstand this deteriorating effect. Various types of rotors were tried. It was finally determined that the semi-conodial blade was best suited to these particular conditions from the standpoint of withstanding erosion. For a given quantity of gas and size of wheel there are a greater number of blades than with the plate type, and the total weight of the metal of the blades is greater. It was also observed that this type of fan concentrated the wear on the fan blade at a point near the central disk, where the gas took a right-angle turn to the outside of the wheel. Therefore the blades were reinforced at this point.

Also it was found that dust was projected at the cen-



CURVES SHOWING EFFICIENCY WITH DIFFERENT SCREEN MESHES

Curve 1 normal cutoff ..... 1,000 r.p.m.
Curve 2 normal cutoff ..... 1,200 r.p.m.
Curve 3 normal cutoff ..... 600 r.p.m.
Curve 4 maximum cutoff ..... 1,000 r.p.m.

ter of the casing when a double-inlet fan was used. It was this portion of the casing that wore more rapidly, whereas the sides were only slightly eroded, if at all. Therefore the center of the casing was protected by means of cast-iron removable plates, constructed with ridges on the sides to make a channel for the dust, and with the added advantage of being able to make the section of gas or "slice" withdrawn larger at this central point where the dust was concentrated, and less along the side. Thus for a given square area of bypass opening there was a greater "slice" at the center, with consequent improvement in efficiency, especially as to the fine particles.

AFTER the concentrated gas was removed it was passed through a small cyclone (also equipped with cast-iron wearing plates) and then reintroduced into the inlet duct for the fan.

Due to the smaller radius, a small cyclone seemed more efficient for a given draft loss than a large cyclone, since $F = \frac{mV^2}{r}$ and to maintain F constant the velocity must increase as the square, as the radius is increased. At the same time if r can be maintained at a low figure and the velocity increased without objectionable increase in power cost, the best operating conditions can be realized. Since the gas in the fan involute is at its maximum pressure and since the outlet of the cyclone at the center and top is at the maximum suction of the fan, the cyclone was built with a small radius and an extremely high velocity. This can be done without increasing the power consumption, as the gas is returned to the inlet of the fan at the same pressure as the gas entering the fan.

CONSIDERABLE variation of this apparatus is also possible. For example, it can be built with two cyclones; with normal operation a single cyclone can be used and with maximum rating or when the boilers are being cleaned both cyclones can be placed in the line. This is generally important, as the concentration of dust may increase approximately 20 times when the boiler is blown.

The efficiency of the fan scroll, acting in the nature of a cyclone collector, is of considerably more importance than the actual efficiency of the small bypass cyclone. The following table will show the relative influence of these two parts of the apparatus, E_s being scroll efficiency, based upon the following formula:

$$E_t = \frac{E_c \times E_s}{1 - (1 - E_c)\, E_s}$$

Constant Scroll Efficiency			Constant Cyclone Efficiency		
E_s	E_c	E_t	E_s	E_c	E_t
90	90	89.0	90	90	89
90	85	88.4	85	90	83.6
90	80	87.8	80	90	78.25
90	75	87.1	75	90	72.95
90	70	86.3	70	90	67.7
90	65	85.4	65	90	62.5
90	60	84.4	60	90	57.4
90	55	83.2	55	90	52.4
90	50	81.8	50	90	47.4

It will be noted from the above that E_t is considerably less affected by the cyclone efficiency than the scroll efficiency.

This condition works to the advantage of the system, since the efficiency of the cyclone cannot be controlled during operation, whereas the scroll efficiency can be regulated by the amount of gas withdrawn and by the size of the "slice" of gas.

Burning Gas Under Boilers

By C. G. Crowley

ANYONE who has operated boilers with gas realizes that it is the ideal fuel, even easier to handle than oil, and even more flexible in operation. This is immediately apparent when changing from oil to gas. It is still more marked, of course, where the change is made from coal to gas. As brought out in a recent number of *Power*, increasing the mileage of natural gas pipe lines means that more and more boilers now burning coal will take to gas or use gas as an auxiliary or supplemental fuel.

The use of gas instead of coal is not without its difficulties. As with coal and oil, it is very necessary that combustion be complete before the gases come in contact with the relatively cool boiler tubes, because of the low ignition temperature of gas. As with fuel oil, it is important to prevent the gas flame from impinging upon the tubes, especially when operating the boilers at high ratings.

The usual practice when burning gas under coal-fired boilers is to cover the grate with firebrick, locating the gas burners in the furnace doors. In the case of chain-grate stokers, the chain grates are usually pulled out and the space bricked up, after the installation of suitable gas control. Under such circumstances, a checkerwork should be built 30 in. or more from the end of the burners, depending upon the size of the boiler and the maximum rating at which it is to be operated.

It is often found that full overload capacity cannot be obtained, on account of lack of furnace volume. Under certain circumstances, the gas burners should be located in the ashpit doors instead of the firing doors. The ashpit can then be lined with firebrick. The result is that the size of the combustion chamber is nearly doubled.

The checkerwork assists combustion by providing an incandescent surface for the gases, in this way insuring ignition, directing the hot gases against the heating surface of the boiler at right angles to it. Tests with checkerwork so arranged show that the effectiveness of a square foot of heating surface is increased about eight times that of a similar area arranged parallel to the direction of gas flow.

Sometimes the orifice of the burner becomes obstructed, cutting down the flow of gas without the attendant's knowledge. Where a number of boilers are operating in parallel there will be a tendency for some boilers to be pushed harder than others, especially when several burners on one boiler are clogged. However, the unequal distribution of load can be prevented where steam-flow meters are used on each boiler.

A CO_2 instrument is particularly desirable where gas is burned, otherwise considerable waste may occur. A gas fire should burn with a blue flame, and a white heat. A white flame is an indication of carbon monoxide.

Some plants are using one burner for every 250 sq.ft. of boiler heating surface, while others are using a burner for every 33 sq.ft. The larger the number of burners the less likelihood of tube failures and the greater the overloads obtainable, since a larger number of burners lessens the chance of flame impingement while distributing the heat developed and utilizes more efficiently the total furnace volume.

Control for Fire Pumps to Meet Insurance Requirements

By H. L. SMITH
Industrial Engineering Dept.
General Electric Company

THE National Fire Protection Association issued during 1929 a new set of specifications to cover motors and control for fire pumps. It is divided into three sections: (1) manual for 600 volts or less; (2) manual above 600 volts; and (3) combined manual and automatic for 600 volts or less. All automatic control panels must have provision for manual operation.

The first type applies to low-voltage, squirrel-cage induction motors; full- or reduced-voltage starting, wound-rotor induction motors; and direct-current motors. The second is for high-voltage squirrel-cage and wound-rotor induction motors. The third has to do with low-voltage, wound-rotor induction motors, direct-current motors, and certain applications of squirrel-cage induction motors started on full voltage.

Controllers for No. 1 and 2 requirements must be inclosed in a ventilated, splash-proof cabinet unless so located as to be free from injury by water escaping from the pump or connections. Controllers for No. 3 conditions must always be inclosed.

If manual control is decided on and the power supply is alternating current the question of whether the squirrel-cage or wound-rotor type motor is to be used is determined by the nature of the power supply, and it should be decided by the underwriters' representative. What the underwriters wish to secure is, with a power supply such that there will be but little chance of interruption of service, a motor and control equipment which will insure, as far as possible, that the pump can be started and operated.

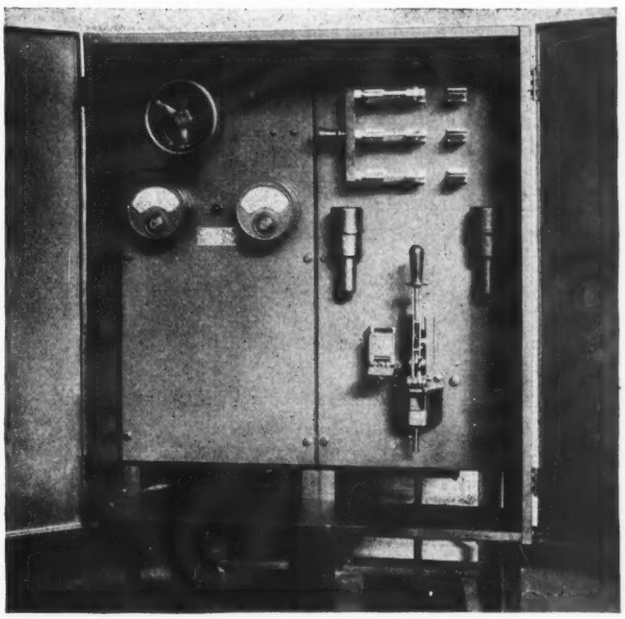
If the motor is connected to lines having a large amount of power back of them, so that the unit under the worst condition will have ample voltage to insure its starting, squirrel-cage motors may be used. If there is any question of the voltage dropping and affecting the starting, wound-rotor motors must be used.

Installations using combined manual and automatic control may be divided into two classes: First, installations where the electrically driven fire pumps constitute a secondary source of water supply; that is, the primary source of supply is a tank, usually located on the roof. Second, installations where the electrically driven fire pumps constitute the sole supply for a sprinkler system.

The majority of fire pumps come under the first classification. For alternating current, it is generally necessary to use wound-rotor motors, though the specifications now permit the use of up to 50-hp. motors designed for full-voltage starting that have been approved by the Factory Mutual Insurance Company.

Under the second classification, the control must be provided with full supervisory service or a substantial equivalent. Provision is made so that the unit can be started, stopped, and the valves operated from a central supervisory station. The starter and valves are provided with switches and interlocks, so arranged as to give a printed record, as well as a visual indication at the central station. The pump is tested each day from the central station to make sure that everything is in operating condition. When the pump starts a signal is given at the central station. With this type of service, frequent starting and stopping is prevented, as a clock mechanism is provided by means of which, if the motor starts three times in succession within a given time, a switch is thrown which connects the motor permanently to the line until it is shut down by hand.

The controller for such motors, either the direct-current or wound-rotor type, would be the same as for the standard fire pump except that a 12-volt direct-current supervisory relay is added and the ammeter and voltmeter may be omitted. Supervised pumps are generally in the range of 30 to 50 hp., and occasionally as high as 75 hp. The fact that a certain type of motor is approved for this service does not mean that this unit could be used without a further check, as it is always necessary for the local underwriters' representative to check carefully the line conditions to make sure that they are suitable for the starting. Cases will arise where the power supply is ample for starting high-reactance squirrel-cage motors even larger than 50 hp. It is felt that approval of this type of motor can be secured if all of the facts are presented to the underwriters.



Fire-pump control panel for 200-hp. induction motor, providing for two sources of power, speed regulation, undervoltage and overload protection

For wound-rotor motors requiring control from approximately two-thirds to full speed with manual starting, there is a panel in which sufficient resistance is included so that, as soon as the old circuit breakers close, the motor comes up to low speed (the speed then being increased, if necessary) through a 13-point drum controller with an undervoltage release. Several panels of this type have been installed in New York City.

. . . RIGHT OUT OF THE PLANT . . .

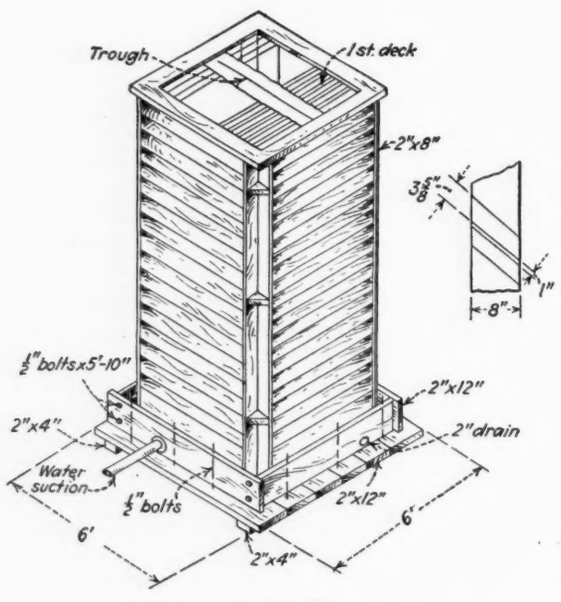
Small Portable Cooling Tower

A SMALL portable cooling tower capable of handling about 70 gal. of water per minute and suitable for small compressors or gas engines is shown in the illustration.

The pond, or basin, is made from 2 x 12-in. x 6-ft. select clear redwood surfaced on all sides, the six bottom boards being grooved to take inserted tongues. The six pieces are assembled with tarred joints. Two inches from the edge of this bottom, and all around, a groove is cut, wide enough to take surface lumber of the same thickness but 12 in. high. The two ends are grooved, and the whole is assembled and bolted to the bottom with half-inch galvanized bolts. A 2x4-in. sill is laid under the ends and the bolts are made fast through this as in the sketch.

The tower frame is made of eight 2x8-in. pieces of redwood sized on all sides. These are cut in ten-foot lengths, and are held together in pairs by corner braces. The posts are placed in the corners of the box and bolted with brass or galvanized bolts. A rail goes around the top of the tower, and two or three decks made from a two-by-four frame with builders' laths nailed on them are equally spaced inside the tower. At the top of the tower a trough built of one-inch redwood and having serrated edges is made to extend across the center of the tower. The incoming water is piped to this trough.

The louver boards are made from clear 1x12-in. redwood, cut to a loose sliding fit between the posts. Cleats to carry these boards are made from one-by-fours, which gives a finished size of about $3\frac{5}{8}$ in. The cleats are cut at 50 deg., as shown, and nailed on the posts sufficiently far apart so that the louvers will slide easily between them. A builder's lath nailed on the back of the post will stop them from sliding through.



Details and dimensions of tower

This about completes the tower and pond. In the bottom a flange is bolted to take care of the size of drain needed; also a flange is bolted on the lower part of the side to be used for the suction line, usually about three inches being enough.

This tower will be found to have sufficient temperature range for the average cooling of circulating water for gas engines or compressors, and can be increased by passing the water through a spray nozzle. In the installation described a two-inch nozzle handling 50 gal. per minute at about 15-lb. pressure would be suitable.

Long Beach, Calif. MAURICE C. COCKSHOTT.

Running on the Leavings

THE foreword by F. R. Low in the Feb. 11 number, entitled "Running on the Leavings," suggests that an equally good one might be written and entitled "We have to have it anyway, so it doesn't cost us anything."

For example, a power company finds it necessary to keep a certain number of trouble men available for call in emergencies. During quiet times, some work is found for these men to do. Often, this work could be done at less cost outside, except that no allowance is made for labor. Next, someone decides that these men could work to better advantage if they were provided with a shop and machine tools. After that, everyone with sufficient authority, who has some pet line of work he wants done, under the excuse that "it doesn't cost anything because we have to have the men and the shop anyway" proceeds to have it done by the trouble crew. Soon it becomes necessary to take on more men, increase the shop facilities, and purchase special material, until it develops into a small manufacturing department doing work that should be charged to other accounts, much of which is unnecessary, and what is necessary often at a greater cost than the devices manufactured could be purchased for in the open market.

To give an actual illustration, a large power company absorbed several smaller ones, and discontinued some of the least efficient plants. One of these was stripped of its machinery and the building used as a warehouse. In rebuilding the system, the salvaged equipment was sent to this warehouse. The original intention was that the usable material should be put in good condition and

stored, and the remainder disposed of. Old chairs and desks from the office buildings were also sent here for storage, as they were considered good enough for use in the power plants. In order to overhaul this salvaged equipment, a machine shop and an electric shop were fitted up, although the company already had repair shops in another location near by. This warehouse gradually built up a large staff of clerks, mechanics and laborers. It was looked on as a good place to keep the trouble men busy when not required for their own work. It was also looked on as a good place to transfer a man to get rid of him. As a consequence, it developed into a loafing place for the poorer grade of employees.

Because "they had to have the shop and the men anyway," the men were kept overhauling equipment that should have been junked, rebuilding it to meet different purposes than those for which it was originally intended, or manufacturing new equipment. A valuation was set on all of this material and entered on the books by the warehouse department. This department was tied in with the purchasing department in such a way that all orders for new equipment were sent through the warehouse, and if possible filled from their stock. This caused complaints from the engineering department that the warehouse was dictating the kind of equipment to be installed in the plant. One piece of equipment that was particularly objected to was a home-made oil switch and solenoid operator, designed several years previously, that proved unreliable in service. Although more improved circuit-breakers could be purchased from manufacturers, a number of these obsolete models were installed over the protest of the operating department. One substation was known as the "second-hand substation," because its two motor-generator sets and all its switches and circuit-breakers were salvaged stock.

This state of affairs finally came to the attention of the general manager, who immediately made a personal investigation. As a result, he ordered the old office furniture burned, most of the stored equipment broken up and disposed of as old metal, the shops abolished, the surplus labor transferred or laid off, and the building restored to its original purpose as a store room.

For another example, a hydro power company was digging a canal to carry water to a new power plant. Because "they had to have compressed air for the machine drills anyway" and "they already had electric power available," it was decided to operate two steam shovels and several hoisting engines with compressed air also. This necessitated the laying of a ten-mile pipe line the length of the canal. Two motor-driven compressor plants were installed. Later on, as the construction work did not make the expected rate of progress, two additional steam shovels were rented from a contractor. Then, since "we had to have compressed air anyway, and, besides, the air pipe line was already installed," two additional compressor plants were erected to carry the increased load. As these would be needed for a short time only, the compressors and electric equipment were purchased second-hand, with cost as the main consideration. As a consequence, no two machines were alike, and gave constant trouble. Then the pipe line proved too small, so part of its length had to be paralleled with additional piping. With this in place, the compressors were able to maintain only 95 lb. pressure at the station and 80 lb. at the shovels, although the working pressure of their boilers was 110 lb. With the low pressure, their output was greatly reduced.

A small ice plant was forced to move to a new location by the termination of its ground lease. Because "he had to have steam anyway for distilled water," the owner decided to use steam power in the new plant.

The new plant was given a larger can capacity. The old ice machine proved too small. Because he "already had an engine and boiler set up in place," the new machine was belt driven. With this set up ready to run, the old engine proved too small, and a brine-circulating pump was found necessary. Because he "already had a belted machine," the new engine was a side-crank, 3-bearing machine, with two small belt wheels between the outboard and center bearings, one for the brine-circulating pump and the other for a belted electric generator. The main belt and flywheel were in the usual place between the engine main bearing and the center bearing. With this set up and ready to run, the boiler was too small, so "because he already had the rest of the plant" a larger boiler and a new boiler-feed pump were purchased. Shortly afterwards, the people who held the mortgages foreclosed, so "because he has to eat" the former owner is now working for wages. The last necessity compelled him to make the only sensible move he made at any part of the story.

These instances prove that one should not allow an imaginary necessity to force him to deviate from the main object, which is to produce the output of his plant at the lowest possible cost.

HOWARD LIVINGSTON.

Los Angeles, Calif.

Loss in Flue Gases

WITH REFERENCE to the comments of Harry Stuart in the March 18 number, discussing loss of heat in flue gases, may I suggest that engineers modernize their methods of treating this and other similar problems.

The problem is much simpler if done in mol quantities and requires no long formula. Take the analysis Mr. Stuart cites: CO_2, 4 per cent; O_2, 4 per cent; CO, 0.2 per cent; and N_2, 81.8 per cent in the dry gas. The dry coal contains 78 per cent of carbon.

In a cubic foot of flue gas the molal quantity of C is $0.142 \div 380 = .000374$. The weight of carbon is $.000374 \times 12 = .00448$ lb. per cubic foot of dry gas. Therefore, the volume of gas per pound of dry coal is

$$\frac{.78}{.00448} = 17.4 \text{ cu.ft.}$$

Since the mean specific heat of flue gas is approximately .0195 B.t.u. per cubic foot in the range of 500 deg. F., the heat loss per pound of dry coal is $174 \times .0195\ (500 - 80) = 1{,}425$ B.t.u.

Mr. Stuart has overlooked another item, if accuracy is desired, and that is the sensible heat of the H_2O vapor from the hydrogen contained in the dry coal. This usually runs 5 per cent or .05 lb. of hydrogen per pound of coal. Since the weight of hydrogen in a cubic foot of H_2O is $\frac{2}{380} = 0.00527$ lb., the volume of water vapor is $\frac{.05}{.00527} = 9.4$ cu.ft. per pound of coal, and the heat loss due to H_2O vapor is $9.4 \times .0233\ (500 - 80) = 105$ B.t.u. Therefore, the total sensible heat going out the stack is 1,530 instead of 1,403 as Mr. Stuart solves.

V. F. PARRY,

Linden, N. J. Combustion Utilities Corporation.

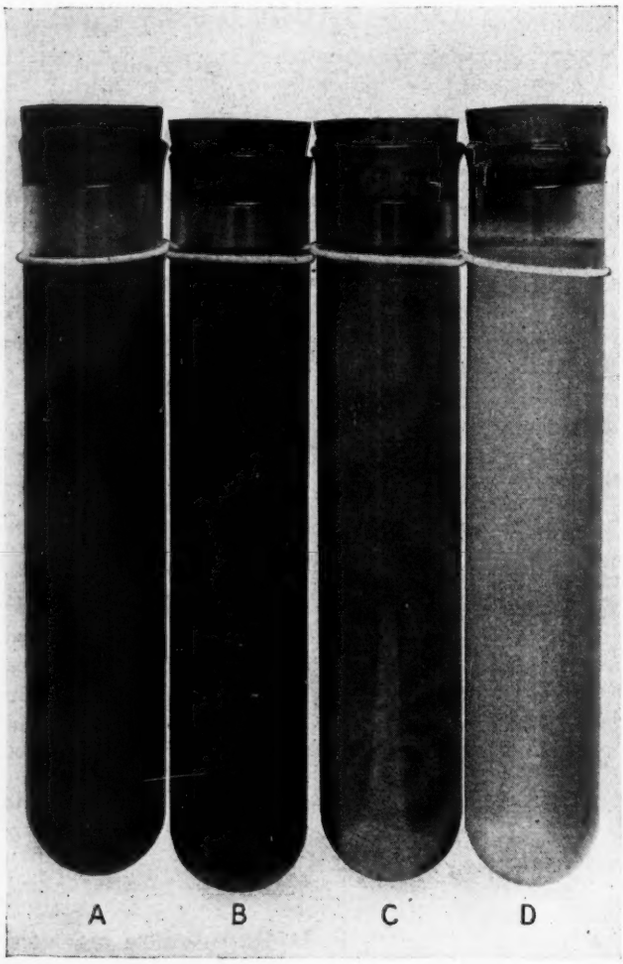
Removing Carbon and Moisture From Insulating Oils

THERE has been much discussion over our system lately concerning the methods used in removing carbon and moisture from oil-switch and transformer oils. As these oils are of the same specific gravity, the same process of purification can be used. Oils of this class become contaminated in three ways: use, exposure, and failure of apparatus.

As replacement is too expensive, some means must be used to purify and clarify the old oil which has lost its dielectric strength. When a considerable percentage of moisture is present in transformer oil, a large part of it can be removed by allowing the oil to remain undisturbed for some time. Even then the oil will still contain considerable moisture in a suspended state.

To provide a better means of removing the moisture and the impurities the filter press method came into use. A pump is used to force the contaminated oil through layers of paper, cloth, or other material having pores too small to pass the carbon and other solids. If considerable solids are present in the oil they soon collect on the blotters and interfere with the passage of the oil.

If the oil contains a considerable percentage of moisture the filter-press method is not so satisfactory. To provide a faster method of removing the bulk of moisture from oils, the centrifugal purifier was introduced. Unfortunately, the characteristics of some contaminated oils are such that a part of the carbon is of the same specific gravity as the oil and forms an emulsion with it, which cannot be separated by the centrifugal-force method alone. As a result, if the centrifugal method alone is used, the oil will be dark, even though its dielectric strength is high. A satisfactory solution to the problem is found in the combined centrifugal and filter press.



Samples of oil taken at various stages of the purifying process

The accompanying photograph shows why it is necessary to use a combined centrifugal purifier and a filter press. *A* is oil which was taken from a 110,000-volt oil circuit breaker. It was passed through a centrifugal purifier 36 times, 20 times with the water-seal equipment and 16 times as a dehydrator. This oil is emulsified and could not be separated from the carbon by a centrifugal purifier. *B* is the same oil that was passed through a filter press only once. *C* is also the same oil, but it was passed through a filter press once and through a centrifugal purifier once, the latter equipped with a water-seal. *D* shows the same oil after it was circulated five times through a filter press and a centrifugal purifier.

Tallassee, Ala. DRUE HOCUTT.

Accident to a Turbine Blower

A LITTLE WHILE AGO I had a conversation with the engineer in charge of a large iron and steel works, who gave full details of an unusual accident to a large turbine blower, and as the same thing might happen at any other works where similar machinery is installed, a description of the accident may be the means of averting a similar occurrence.

There were two large turbine blowers installed to supply the air to a blast furnace, the intention being to have one set as a stand-by. Delivery pipes were connected to a common header, and a shut-off valve was placed on the delivery side of each blower. So that the spare set should always be ready for use, it was the practice to run them alternately.

The accident happened during the absence of the chief engineer, and it became necessary to change over from one set to the other. This operation had to be done without interrupting the blast. The second engineer therefore begun to run the spare set up to speed before shutting down the first blower. When the spare blower was ready to take the full load, he ordered his assistant to shut the steam valve of the first blower. The assistant did so, but he did not close the air-delivery valve. The result was that the blower end of the first set acted as a turbine, and began to revolve the turbine in the opposite direction.

The assistant did not notice the stopping and subsequent reversal of the machine, which took place very quickly. Noticing that the blower did not slow down, and still not noticing the reversal of rotation, the man again endeavored to close the steam valve, which was already shut off. The machine raced, the governor, of course, being out of control. A final smash was averted only by failure of the oil pump. The pump was designed to run one way only, and when the reversal of rotation occurred it no longer operated, with the result that the main bearings quickly heated up to the seizure point.

Fortunately, the spare set carried the load until the first one was ready to run again. Subsequently, automatic shut-off valves were fitted to the air deliveries, rendering a similar occurrence impossible.

West Bromwich, England. H. MAPLETHROPE.

From Among Readers' Problems

Conducted by
L. H. MORRISON

COOLING BY FLASH AMMONIA GAS—*The temperature of liquid ammonia in the receiver is 84 deg. F. For the ammonia in the cooling coils to evaporate it must be cooled from 84 deg. to 8 deg. F. How much, in per cent of heat-absorption capacity, is lost by this liquid cooling?* A.L.B.

The receiver pressure is not given, so it will be assumed that the liquid in the receiver is not subcooled and is at a pressure corresponding to the 84 deg. F. temperature, that is, 149 lb. gage. At this pressure-temperature condition each pound of liquid ammonia contains 136.6 B.t.u., as measured from liquid at —40 deg. F., the starting point of the present-day ammonia tables.

After the ammonia flows to the evaporating coil, and evaporates at 8 deg. F., the vapor will contain a total of 614.3 B.t.u. So the amount absorbed from the brine is 614.3 — 136.6 = 477.7 B.t.u. This is the effective cooling. However, if the liquid had been previously cooled to 8 deg. F. before admission into the coils, it would have contained the heat of the liquid of 51.6 B.t.u., so the effective cooling would have been 614.3 — 51.6 = 562.7 B.t.u. The loss in effective cooling through a failure to subcool is then $\frac{562.7 - 477.7}{562.7}$ = 15 per cent.

REGULATING DIRECT-CURRENT GENERATOR'S VOLTAGE — *An 85-kv. direct-current generator is driven by an induction motor. The speed of the motor decreases as the load increases and causes the voltage of the generator to decrease. What may be done to improve the voltage regulation?* W.H.W.

There is nothing that can be done with the motor except to see that the frequency and voltage of the circuit on which it operates are correct. This is, of course, assuming that the motor is in good condition, mechanically and electrically. Assuming the generator is of the compound type, it may have a shunt across the series field terminals. Reducing the cross-section of this shunt or removing it entirely may increase the compounding of the generator sufficiently to give the desired voltage regulation.

Failing in this, there are possibilities that the number of turns in the series winding can be increased at a not unreasonable cost. Setting the brushes ahead of the neutral will improve voltage regulation. This adjustment is limited by sparking of the brushes and should be done with care. It may be that the brushes are now set back of the neutral. If that is so and the machine will operate satisfactorily with them slightly ahead of the neutral it will improve the voltage regulation considerably.

Setting the polepieces closer to the armature will improve the voltage regulation. If the generator is connected to the motor through a belt or a chain drive, changing the pulley or sprocket ratio to increase the generator's speed will also improve compounding of the generator. The answer to the problem will probably be found by taking those suggestions that can be applied and using them to the best advantage.

VOLUME OF COMBUSTION AIR—*One pound of air at 62 deg. F. has a volume of 13.14 cu.ft. The grate is 5x6 ft. The rate of combustion is 12 lb. of coal per square foot per hour. Assuming the coal to be 60 per cent carbon and the remainder ash and that 1½ times the theoretical amount of air is furnished, how many cubic feet of air at 62 deg. F. is required per minute?* J.B.C.

With a 5 × 6 = 30 sq.ft. grate and a combustion rate of 12 lb. of coal per square foot, the total coal burned per hour is 30 × 12 = 360 lb. If 60 per cent of this is carbon, there is 360 × .60 = 216 lb. of carbon to be burned. The chemical reaction of oxygen and carbon is:

$$12C + 32O_2 = 44CO_2$$

This indicates that for each 12 lb. of carbon burned there is required 32 lb. of oxygen, so that 216 lb. requires $216 \times \frac{32}{12} = 576$ lb. of oxygen. As each pound of air contains 0.23 lb. of oxygen, the weight of air needed for complete combustion will be $576 \times \frac{100}{23} = 2{,}504$ lb. If air has a volume of 13.14 cu.ft. per pound, the total volume will be 2,504 × 13.14 = 32,902 cubic feet.

PREVIOUS QUESTION

Discussed by Readers

THE QUESTION

WILL some of POWER'S *readers tell me of their experiences starting squirrel-cage motors on full-voltage, in sizes of 30 hp. and above?* F.A.

A REPORT of experience with across-the-line starting induction motors is of little use unless accompanied by information on the conditions under which the motors operate. Where motors connect directly to equipment that has no backlash in it they can be started in most any size by connecting directly across the line. It is becoming general practice in power plants to start the motors on many of the auxiliary drives by connecting them to full voltage. This applies to high-speed as well as to slow-speed motors. Induction motors rated at 1,250 hp. and 3,600 r.p.m. are designed so that they may be started on full voltage.

Slow-speed synchronous motors of much larger capacity have been built for across-the-line starting. A 3,000-hp. unit driving a reciprocating gas compressor is started on full voltage. In this case the power is supplied from an industrial plant.

In a large cement mill all induction motors below 50 hp. are started on full voltage. These motors are designed for 440-volt operation. Motors of 50-hp. rating and larger are designed for 2,200-volt operation and are started from a 1,400-volt bus by means of double-throw interlocking contactors. During an emergency that lasted for several weeks the 1,400-volt source of starting power was not available. The starting bus was connected to the 2,200 volts and the motors were started on full voltage. Induction motors up to 100-hp. and synchronous motors up to

500-hp. capacity were started this way during the time that the starting source was out of commission. No bad effects were noted on the motors or starting equipment, and although the generator capacity was only 4,500 kw. the starting peaks did not bother the system.

Where machines have considerable lost motion in their gearing, such as in chain drives, full-voltage-start motors should be applied only, if at all, after a careful consideration of the effects of sudden starting on the driven machine. Drives or machines that have high inertia parts, such as flywheels, may be unsuited for full-voltage starting. Where these questions do not exist induction motors of almost any size may be started by connecting them to full voltage, if there are no objections from those supplying the power.

The old objection that starting motors causes flickering of lights is mainly imaginary. Household devices have come into general use that cause lights to flicker more frequently than starting induction ever did, and there is no complaint. Furthermore, most industrial induction motors are started in the daytime, when flickering of lights is least objectionable. Some household devices start as frequently at night as in the daytime, and cause a flickering of lights when it is most objectionable, but the users do not seem to consider this a serious matter. From this it would seem that the old objection to lights flickering was seriously overexaggerated.

When applying modern induction motors, if the machine and drive will stand full-voltage starting and it will be allowed on the power system, this method is the preferred. Motors of any size can be had for this system of starting and the only thing that has to be considered are the conditions external from the motor. W. W. WILSON.

Cleveland, Ohio.

HIGH-REACTANCE motors up to 1,000-hp. capacity are being manufactured that can be thrown directly across the line at starting. The ordinary squirrel-cage motor draws about 6 to 7 times full-load current on starting, which is apt to cause considerable disturbance when operating large-size motors. Some objections are the probable damage to the windings due to heating and magnetic stresses, the possibility of opening the circuit breaker protecting the line, and the drop in line voltage causing lights to flicker. It is also possible that damage may be done to the driven machine as a result of breaking a gear tooth or some other member. NOBLE WATKINS,

Assistant Electrical Engineer,
East Liberty Y.M.C.A.
Pittsburgh, Pa.

RECENTLY a slip-ring induction motor that had been in service several years was provided with a new double-winding squirrel-cage rotor. No change was made in the stator winding. This motor had previously given considerable trouble by flashing over at the slip rings. It is rated at 100 hp., 440 volts, 60 cycles, 1,800 r.p.m. With the new rotor it starts satisfactorily on full voltage.

I have charge of three other motors of 125-hp. rating that are also provided with double squirrel-cage rotor windings. Two of the motors operate at 1,800 r.p.m., while the third is a vertical type, operating at 900 r.p.m. Not only do we start these motors by throwing them directly on the line, but there is no transformer between the generator and the motors, both operating at 4,100 volts.

The motors are on city water works service and were chosen for sake of simplicity and reliability. It is true that smoother starting would be obtained by using slip-ring motors, but for such service it is felt that the slip-ring motor is not as reliable and is much more expensive. I believe that the use of compensators for starting squirrel-cage motors is rapidly becoming obsolete.

It may be interesting to know that these motors are started from 600-kw. steam turbine-generators or from the lines of the local power company with no difficulty on either system, although some flickering of lights is noticed when they are started on the smaller system.

EARL E. NORMAN,
Superintendent,
Dept. of Public Utilities.
Kalamazoo, Mich.

WE HAVE two squirrel-cage motors, rated 75 hp., 4,000 volts, 3 phase, 60 cycles, 900 r.p.m., which are regularly started on full voltage. They are used for driving 50-kw. direct-current exciters. The regular practice is to change over exciters once a week. These two sets have been running for over two years and we have had no trouble of any sort. We would have no hesitation in installing other motors for full-voltage starting where the accelerating period is short.

We have a number of 20-hp. 550-volt motors, mostly operating at 1,800 r.p.m., driving chemical mixers of various types. Some of these operate reversing and others in one direction only, and have quite heavy gearing and large speed reduction. All are equipped with automatic centrifugal clutch couplings, and the motors are started on full voltage. In many cases the motors are started and stopped several times an hour. There has been no trouble with any of these motors due to full-voltage starting.

Reference was made to 20-hp. motors, although the questioner specified motors of 30 hp. and above. I believe that he need have no fear of starting motors on full voltage in sizes up to 100 hp. provided the conditions under which the driven machine is operating are favorable.

C. E. OLIVE, *Chief Engineer,*
Canadian Celanese Limited.
Drummondville, Quebec.

THE OLD objection to throwing an induction motor of any size across the line in starting was due more to poor regulation of the line resulting in a momentary drop in voltage than to any damage that might have been done to the motor.

I have installed magnetic across-the-line starters on squirrel-cage motors up to 50-hp. without the least trouble developing. The motors were of the older type and not originally designed for this service. The motors in question have been operating in this manner for four years.

As an interesting fact, one large paper company is at present starting 1,400-hp. synchronous motors across the line. The motors operate grinders, each grinder motor representing about 3½ per cent of the total generating capacity.

St. John, N. B. J. C. NUTTER.

DURING the past year we have installed several full-voltage start motors, ranging in size from 30 to 75 hp., in a large paper mill. The motors have given no trouble and line disturbance is not noticed when starting.

They are all direct connected to pumps of various kinds, and some handle quite heavy stock. One of the 60-hp. motors is stopped and started about every half hour. The automatic across-the-line starters stand up very well and require only occasional inspection and repairs. They are easier to inspect and repair, as well as to operate, than reduced-voltage starters, and it is not necessary to carry so many repair parts. W. E. KRUGER.

Wisconsin Rapids, Wis.

A Question for Our Readers

WE use an average of 2,000 kw. per hour, generated by a condensing steam turbine with a water rate of 15 lb. At the same time we are using for processes 20,000 lb. of steam at 30 lb., and 3,000 lb. at 90 lb., through reducing valves from the boilers. Our electrical load has increased so that we will shortly need to have 1,000 kw. more capacity. The boilers are built for 200 lb.

Will it be better to install a bleeder turbine to draw off at 30 and 90 lb. or install a back-pressure turbine to handle all the load? P.C.B.

Suitable answers from readers will be paid for and published in the May 13 number.

New Facts Brought Out by Nozzle Research

REPORTS of the British Steam Nozzles Research Committee are printed from time to time in *Engineering* (London). A series of recent tests described in the February 28 number of that journal revealed the effect on efficiency of shape of section, entrance conditions in straight nozzles, radius of curvature of impulse nozzles, rounding the entrance in curved nozzles, bevelling of nozzle box, degree of superheat and linear dimensions. Some of the more interesting conclusion are brought out in the following brief digest:

Previous tests have indicated that the ratio of length to breadth in nozzle cross section has little effect on efficiency. Further experiments conducted with extremely flat nozzles (3x⅛-in. opening) confirm the conclusion that the effect of section shape is negligible.

The very high efficiency values previously obtained with convergent straight nozzles pointed to the importance of entrance rounding and of short throat length in reducing losses to a minimum. Therefore, an investigation was made to study the gain in efficiency resulting from rounding the nozzle entrance as compared with nozzles having a sharp edged entrance. It was shown not only that the sharp edge reduced the efficiency substantially but that it also made the nozzle less stable in operation with an increased liability to error in testing. A great energy loss in the sharp edged nozzle is associated with a *vena contracta* in the portion of the channel immediately following the entrance; subsequent enlargement of the bore near the outlet is the cause of violent turbulence.

The effect on velocity losses of sharp edged entrance to straight nozzles, as revealed by these tests, was so striking that a closer investigation was made of curved impulse nozzles of practical shapes. In these, owing to the convergence of the nozzle channel itself, the effect of sharp edges was much less marked than in the case of straight nozzles.

That the energy loss in curved nozzles is, to a great extent, associated with curvature was shown by the general difference in efficiency levels which exists between straight and curved types of nozzles. No curved nozzle yet tested in this research had shown an average velocity coefficient of more than about 96 per cent, a value which compares unfavorably with that of 99 per cent of the most efficient straight-axis nozzles. Much of this loss is probably inherent in the flow of steam through curved passages, but it is reasonable to suppose that its amount is governed not only by the total angle through which the steam is turned, but also by the manner in which the turning is accomplished, and, in particular, by the radius of the curvature of the mean path of the stream.

The experiments with nozzles of different radii of curvature showed a distinct, but small, increase in velocity coefficient with increased radius, although at low steam velocities the reverse may be true. In another set of tests brass strips were laid along two sides of the opening to round off the sharp edges at the entrance. A slight improvement in efficiency resulted.

An early feature of these experiments has been the discovery of the "flopping" of the jet. This is a diversion and reduction of efficiency of the jet which occurs when the steam, after leaving the nozzle channels, passes near any flattened surface. In the normal arrangement, the face of the nozzle box on the downstream side forms a flat surface extending about ¾ in. on each side of the nozzle openings. To study the effect of this the sides of the boxes were cut away at an angle of 45 deg. leaving only a sharp edge to form the boundary of the steam passage. An appreciable increase in efficiency resulted. It is probable that the steam jet, in traversing the distance which separates the impulse plate from the nozzle, sets up violent eddying motions in the surrounding steam, and that the nature and intensity of these eddies depends, to a certain extent, upon the shape of all parts of the apparatus in the vicinity of the jet.

Another set of tests was made to determine the effect of the degree of superheat upon nozzle efficiency. The results showed a difference of velocity coefficient, in favor of the lower superheat, to the extent of over 1 per cent at the lower velocities. However, at high velocities the higher superheat gave the higher efficiency. The information gathered made it clear that any change of nozzle efficiency resulting from an alteration of steam temperature is likely to be of little account in a multiple stage turbine as compared with the beneficial effects of additional superheat upon the efficiency of the turbine as a whole.

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Safety as an Investment in Power Production

By L. Hansen

THIS FACTOR in the production of power cannot be measured in dollars and cents alone. No one can figure with any degree of accuracy the value of a human life. It is true some organizations have established a price for a life, or even a cripple, but the price paid by various industries and utilities is not an accurate measure of the damage done to the unfortunate worker's family.

Practically every state in the union has established through its department of labor an organization that is trying to stamp out industrial accidents. The National Safety Council has the same purpose. There are other organizations, some small and some large, all working along the same line. All of these have made wonderful progress in the last ten years, but nevertheless industrial and public utility power plants continue to have a large number of accidents among their workers. The average wage-earner is not safety minded. He does not think of a safe way or method to do the work that he is paid to accomplish.

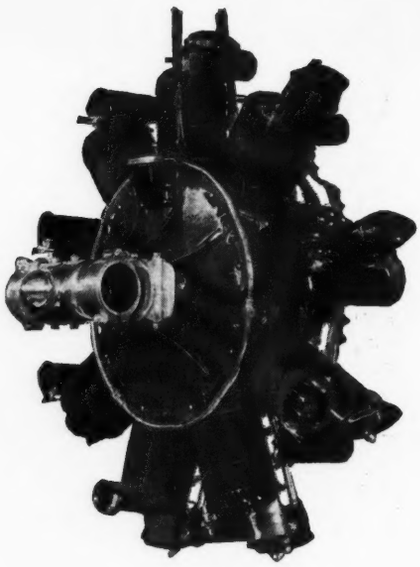
However, the blame cannot all be placed on the immediate worker. The trend of safety work today, through the various organizations throughout the country, is being placed on a sound workmanship basis. They are teaching each worker the necessity of looking out for his own welfare, and to never endanger the safety of his fellow-worker. It is not only necessary to teach the worker this, but he must be "sold" on the idea. When this has been done the elimination of a large number of so-called unavoidable accidents is in sight. It is just as necessary for a corporation to demand an hour of safe work as it is to demand an hour of skilled work. The hour of skilled work may cost many times what it should if the workman performing the work should have an accident.

The hazards in power production are numerous. The general trend of fast production has placed on the market many new devices for labor savings. This, to a certain extent, has cut the number of accidents in large stations, but it is in the small stations or power plants for industries that the hazards are overlooked. Large corporations are spending thousands of dollars each year to educate their workmen to a point where they fully appreciate their responsibility.

This is not only true in the larger central stations, but in a number of growing industries that produce their own power. However, the small power plant is not in the same position. The investment is small, therefore the number of workers per plant is small. Is it a wonder that the owners of small industries do not call their forces together and endeavor to sell them safety? In their minds conditions are forcing them to take a chance. They meet all the legal requirements by taking the required amount of insurance, and pray that their foremen will keep the plant running.

Neglect is the foundation of most all hazards. Neglect and carelessness are twin brothers. Where a plant is well kept in regard to housekeeping few accidents occur.

Details of the PACKARD AVIATION DIESEL



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The outstanding feature of the recent Detroit Aircraft Show was the Packard radial airplane Diesel. For some months the press has been full of discussions of this engine, but only last week did the Packard Company permit definite information to become public.

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AS APPARENT from the photograph, this 225-hp. Diesel is of the radial 9-cylinder type. Cylinder bore is 4⅛ in. and the stroke is 6 in. At 1,950 r.p.m. the output is 0.23 hp. per cubic unit of piston displacement, with a brake mean effective pressure of 94 pounds.

The engine includes several features that are decidedly novel and are departures from general Diesel engine practice.

Aviation requirements necessitate the minimum of engine weight. Consequently, to reduce the weight of the crankcase the cylinders are not held to the case by tugs and studs. Instead, two rings, or hoops, are placed around the periphery of the crankcase and fit into grooves in the cylinder base lugs. Turnbuckles are used to lighten these bands and the initial tension applied puts the crankcase under compression. The working stresses placed on the crankcase are thereby held within reasonable limits in spite of the weight of only 34 pounds.

The cylinder design follows that originated by Dr. Herman Dorner, Packard consulting engineer. Each air-cooled cylinder has but a single valve to admit the air on the induction stroke and permit the escape of the burnt gases on the exhaust stroke. This valve is placed in the cylinder head and is operated by a push rod and rocker from a cam ring keyed to the crankshaft, quite after the usual aviation engine practice. The outlet from this valve is provided with a short nipple so that the exhaust is discharged backward, while on the induction stroke the fresh air passing through the nipple is drawn into the cylinder. For idling operation this nipple has a deflector so that some of the exhaust gases are re-aspirated into the cylinder.

In accordance with past Packard practice on gasoline engines, a multiplicity of springs is used. The actual number on each valve is twelve, the object being both to prevent the liability of loss of a cylinder due to the breakage of a single valve spring, and to reduce the possibility of surging in the springs making the valve operation irregular.

The heat losses through the cylinder walls being lower in a Diesel type than in a gasoline engine, it was felt unnecessary to use a separate cylinder head of aluminum alloy for better heat conduction. A closed-end steel cylinder is therefore employed, with an aluminum alloy cover, cast with cooling fins.

The aluminum-alloy pistons and the connecting rods follow standard practice,

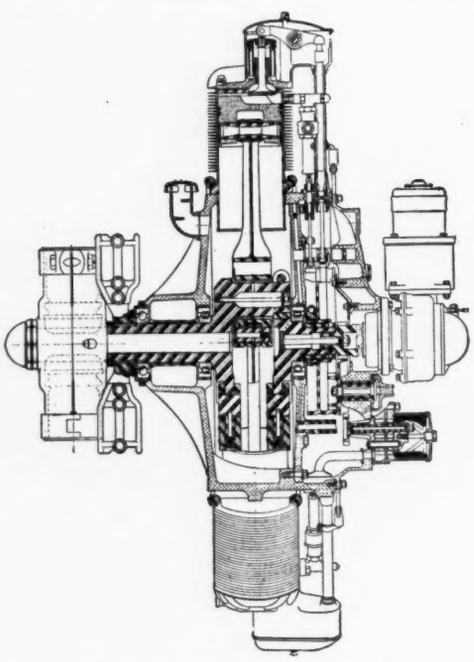

Fig. 1—Cross-sectional view of Packard Diesel

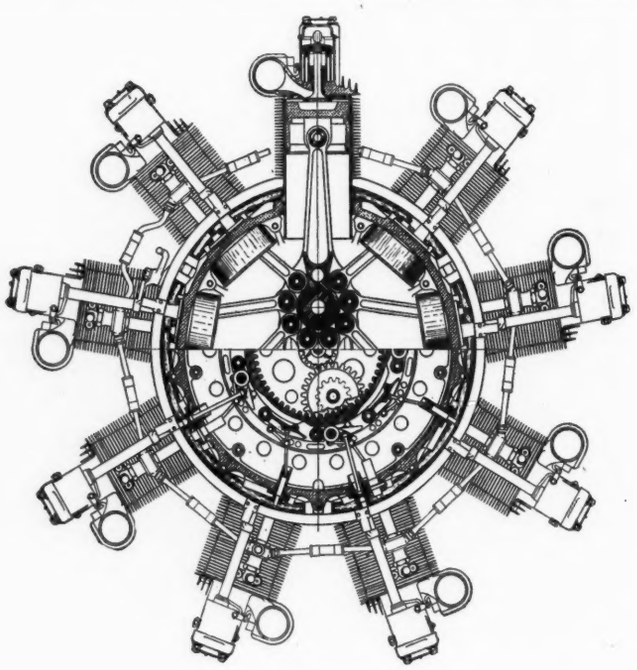

Fig. 2—Side view of the engine

the master-rod assembly being of the conventional type. The piston crown carries an eccentrically placed pocket which is claimed to provide the swirling turbulence necessary to high-speed operation. Each piston carries two compression rings and one scraper ring low on the skirt. The crankshaft is also normal, being of the split type, with the front and rear halves bound together by a clamping bolt. The main crankshaft rests in both roller bearings, the front one being mounted in the crankcase itself and the rear one is a removable plate, or diaphragm, fitted into the crankcase in line with the rear cylinder-clamping band. The diaphragm itself is located in place by studs, and carries most of the working parts pertaining to the fuel system, as well as the rear main bearings.

Mechanical injection is employed, with an individual fuel pump for each cylinder. This pump, as in Dorner's original design, is combined with the spray valve and is located at the top of the cylinder barrel, so that the oil sprays into the recess in the piston crown. A push rod and rocker operates the pump from the circular cam ring already referred to. Fuel injected into the cylinder is regulated by the pump stroke, which is varied by shifting the cam rocker to alter the obliquity of the pump push rod.

The nine fuel pumps are supplied with fuel through a circular pipe line fed from an auxiliary pump. The pressure on this suction line prevents gas binding in the injection pump, a not uncommon occurrence.

As will all high-speed Diesels, the maximum pressure cannot be held within the slow-speed range, and 1,500 lb. per square inch is reached at operating speeds.

The claim is made that the engine, at any setting of the pump control, will show a higher r.p.m. at altitude than at sea level, and it is contended that this is due to the Diesel principle. That is hardly correct. If the engine does turn at a high r.p.m. at a high altitude it is not traceable to the development of more power, but to the reduced resistance of the lighter air. No doubt, this does not occur with the gasoline engine, which has an air-to-fuel ratio only slightly greater than that theoretically necessary. At high altitude, then, the reduced density of the air does not introduce enough oxygen and fuel into the cylinder to permit the same development as at sea level. With a Diesel the amount of excess air at sea level is so great that ample oxygen is present at high altitude to permit the burning of almost the sea level fuel supply. But the increased r.p.m., as has been stated, is due to lower propeller resistance.

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Chemical Training for Power Plant Engineers

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These are the opening and closing paragraphs of a paper delivered last year by Professor Work at the Columbus, Ohio, symposium on "Boiler Room Chemistry." Many technical graduates will agree with him that power engineers need more chemistry than they have been getting in school and that the emphasis should be on physical chemistry rather than on analytical work.

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By Lincoln T. Work
Columbia University

IT WAS my privilege recently to discuss corrosion with some of the engineers who control the operation of boilers generating steam at 1,200 lb. pressure. In their discussion they indicated that after several months of operation a small amount of hydrated iron oxide had been found deposited at one point in the boilers. After first inspection it was cleaned out and did not reappear because the dissolved oxygen in the feed water was kept at zero by the Winkler test.

Furthermore, the water was tested frequently with silver nitrate to detect the presence of chlorides, and the pH values were closely controlled to prevent acid corrosion or too great causticity. These men discussed intelligently the relative merits of tri-sodium phosphate and sulphate-soda treatment of raw water. It is indeed rare to have the maintenance division show as thorough an appreciation of the chemical problems as in this case.

This visit brought out vividly the growing importance of chemistry in the power plant, for times are changing. With the higher pressures, problems which once were troublesome are now acute, and their answer must be had by anticipating the difficulty, lest there be serious consequences. Corrosion is one of the important problems, but not the sole one, affecting modern power plants. The chemistry of the metals, of fuel processing, of combustion, of refractories, and of lubrication are all significant.

At the present time chemistry plays an indifferent part in the training of mechanical engineers. To illustrate, H. P. Hammond[1] shows that there is a distinct continuity and interlocking of most of the courses in this curriculum. Chemistry alone is an isolated entity. This lack of connection between chemistry and mechanical engineering seems to be generally recognized. It is, in part, through the failure of the professional courses to recognize the value of chemistry, and also through failure of the chemist to give instruction in those fundamental fields which have a practical bearing on power plant operation.

With respect to the first of these Kirk and Heisig[2] have indicated some of the difficulties in correlating chemistry with the professional engineering curriculum:

> More criticism has been directed toward the subject matter taught in chemistry than that in physics. This is due, in our opinion, to two related causes. First, the course in physics is more definitely standardized than that in chemistry. Second, professional courses taught in engineering departments are based more definitely on the generally accepted standard courses in physics. The relationship between advanced professional courses in engineering and the fundamental course in chemistry is not so well established.

With respect to the second, that is, the nature and extent of chemical training for the power plant engineer, some suggestions are offered. Courses in general chemistry are departing from the predominantly analytical phase and are dealing more with the physical chemistry of the inorganic compounds. While this trend is in the right direction, the subject matter so taught is not usually adequate as a preparation for the chemistry of the power plant, for it does not deal with the electrochemistry of corrosion, or the high-temperature reactions of ash and slag.

Of the courses which follow this, that of physical chemistry would most nearly complete the preparation of direct value to these men. However, it does not usually occur in the curricula until advanced years, and is usually omitted from mechanical or electrical courses.

Without detracting from the courses in the chemistry of engineering materials which are sometimes given to engineers, I would suggest a stronger fundamental training in physical chemistry because of its direct application to so many of these problems. Furthermore, it has been suggested that all men so trained should have a working knowledge of chemistry which is at least equivalent to their knowledge of electrical subjects. In most engineering curricula this would represent an increase in the amount of chemistry taught.

[Professor Work's complete paper was published in the February, 1930, number of the *Journal of Chemical Education*—Editor.]

[1] *J. Eng. Educ.* (Sept., 1927).
[2] *J. Eng. Educ.* (April, 1927).

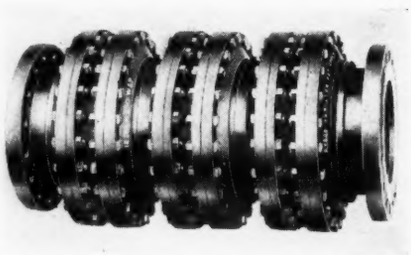
WHAT'S NEW IN PLANT EQUIPMENT

HOW THE MANUFACTURER CONTRIBUTES TO THE JOB OF GENERATING, TRANSMITTING AND APPLYING THE POWER SERVICES

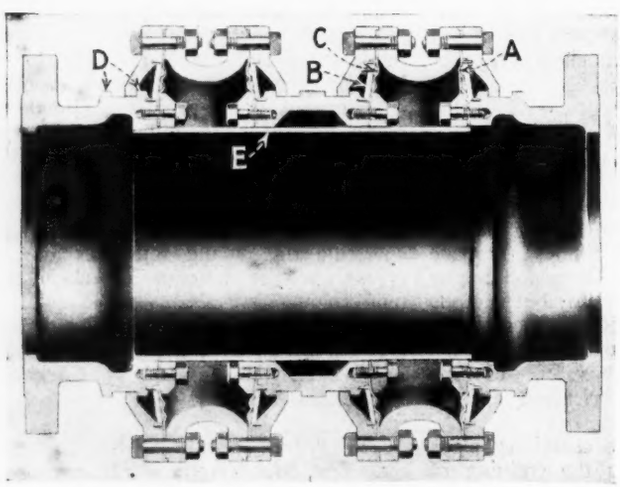
Multiple-Diaphragm Variator for High Pressures and Temperatures

THE DESIGN of the packless expansion joint for use on high pressures and temperatures illustrated follows closely the fundamental principles embodied in the low-pressure expansion joint or variator made for several years by the same manufacturer, American District Steam Company, North Tonawanda, N. Y.

Referring to the illustrations, the joint is made up of one or more expansion units, two of which are shown in the sectional view. As will be apparent from the section, flexibility is provided by corrugated steel diaphragms, as at *A*, clamped between flanges. All the pressure and movement on the diaphragms is absorbed through the sectional backing plates *B* directly by the body of the joint. Circular supporting rings *C* under the diaphragm corrugations evenly distribute the flexing of the diaphragms: The amount of movement on any one diaphragm is controlled by the inward and outward limit stops *D*. Each diaphragm accommodates a full $\frac{3}{4}$-in., movement and a sufficient number of these are added in multiple arrangement to suit the temperature variation and installation conditions involved. Internal cylinder *E* provides for a straight-through flow and also prevents scale or other matter from accumulating in the joint.



Variator with six diaphragms in multiple arrangement



Sectional view of expansion joint equipped with four diaphragms

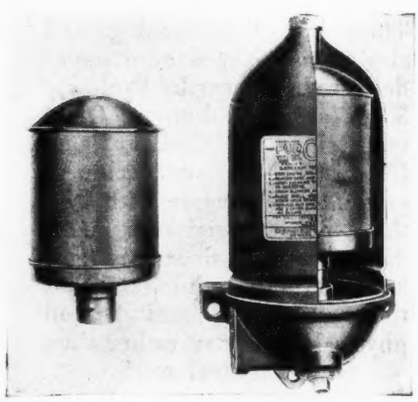
The body is furnished in electric cast steel for temperatures up to 750 deg. F. and working pressures up to 400 lb. Cast-iron bodies are used for pressures up to 250 lb. and a total temperature of 400 deg.

Joints are available in standard pipe sizes from 3 to 20 in. and can be furnished with ends beveled for welding.

Oil Filter With Metal Filtering Element

ALTHOUGH made in sizes to meet practically any requirement, the "Purolator" illustrated, with a metal filtering element, is particularly suitable for application to Diesel and other types of heavy-duty industrial engines. It has been designed to give large area of filtering element within a small cubical measurement, and accurate and uniform spacing of successive layers of metal assure positive filtration and good flow and ready accessibility for cleaning.

The filtering medium consists of a wedge-shaped metal ribbon, on one of the flat surfaces of which are raised spots 0.003 in. high, forming spacers at regular intervals. Because of the wedge shape of the ribbon, the filtering slots are wider behind the filter-edge than at the edge. By this means it is claimed an accurate degree of filtration is obtained without clogging. Much of the dirt filtered from the oil slides down the element surface and falls to the bottom of the base, from whence it can be drained. The dirt that remains on the surface of the filtering element can be washed off easily.



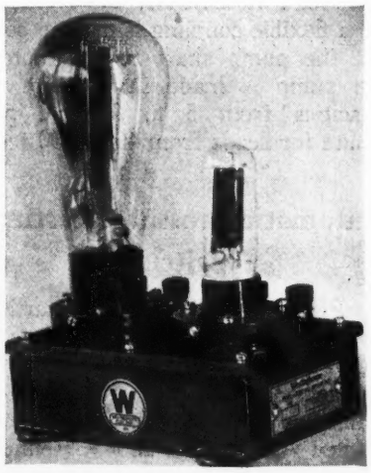
Filtering element and cut-away view of assembly

Elements for the B-type unit are made in two sizes, the B-15M and the

B-1M. The former is 3⅛ in. in diameter and 4⅛ in. long, with 4,150 lineal inches of filtering slot 0.003 in. wide. The latter is 4⅛ in. in diameter and 4¼ in. long, with 5,550 lineal inches of filter slot. The Purolator is put out by the Motor Improvements, Inc., 365 Frelinghuysen Ave., Newark, N. J.

Photo-Electric Cell and Amplifier Unit

AMONG the many industrial uses to which the photo-electric cell has been put are automatic smoke detection, recording of smoke density,

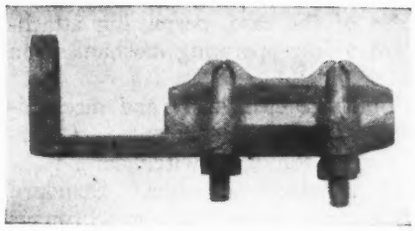


Cell and amplifier in one unit

lighting control for turning on and off artificial lights according to the intensity of the natural light, and ringing alarms, as well as numerous other applications. To meet the demand for a device of this type, a photo-electric cell with an amplifier is now produced as a unit by the Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa.

The photo-electric cell, often called the "electric eye," is a light-sensitive device. When light falls upon it, voltage having been applied to the cathode, a current passes by means of electron emission from the cathode to the anode. This current is very small, but when amplified operates commercial relays.

The amplifier unit shown in the illustration consists of a die-cast aluminum box in which are mounted the necessary coupling devices. The top, a Micarta panel, is provided with two four-prong bases for mounting the photo-electric cell and the amplifier tube. All of the wiring is concealed, connections being made to binding posts on the top panel.



Improved solderless terminal lug

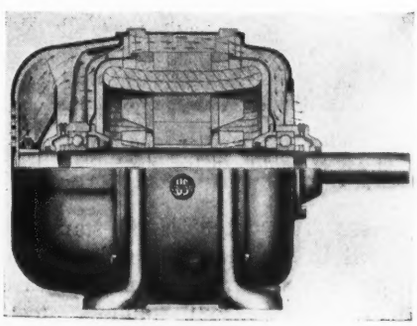
Solderless Terminal Lug

THE compression type of solderless terminal lug for use with air-break and oil-break switches illustrated bolts directly to the equipment contact block or stud, and the line conductor is clamped in position by means of U-bolts which tighten down, forming a solderless compression joint. These terminal lugs, which have been introduced by the Delta-Star Electric Company, 2400 Fulton St., Chicago, Ill., are available for a wide range of conductor fittings.

Sealed Metal Housing-Incased Motor

AN IMPROVED motor especially suitable for use in industries where dangerous fumes, moisture, abrasive-laden air or dripping acids or alkalies are prevalent is announced by the United States Electrical Manufacturing Company, Los Angeles, Calif.

As will be apparent from the illustration, the motor is incased in a



Totally inclosed air-cooled motor

sealed metal housing, outside of which is a chamber that is air-blasted by positive fan action. The air is forced through the chamber as indicated by the arrows. Any dust, dirt or moisture are immediately expelled from the outer casing, thus preventing any foreign matter from entering the inner motor casing. The motor is equipped with ball bearings and asbestor-insulated windings.

Megohmer for Resistance Measurements

THE ILLUSTRATION shows a wide-range resistance-measuring instrument known as the Paragon Megohmer recently added to the line of Siemens & Halske, distributed by Herman H. Sticht & Company, 15 Park Row, New York.

The instrument consists essentially of two units, the generator and the instrument proper, either of which may be removed from the case without disturbing the other. The measuring system is of the differential type, with one series, one shunt, and one compensating coil. The use of unusually powerful magnets permits the coils to be mounted symmetrically on the shaft, giving a well-balanced moving system. This feature has

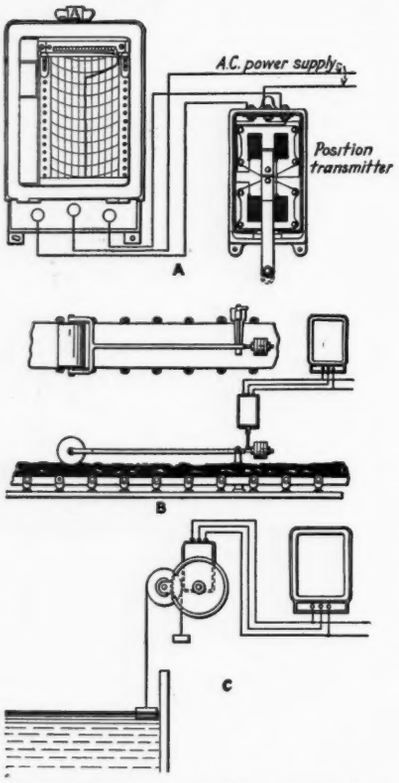
Paragon Megohmer

also made it possible to eliminate the usual leveling screws.

A self-contained generator unit driven through fiber gears from a small crank furnishes the current for the instrument. An improved centrifugal-type clutch assures constant voltage at speeds in excess of 120 r.p.m. of the crank handle. Another feature of the generator is the brush-holder arrangement. The holders are assembled in a complete unit, with adjustable rocker to assure perfect commutation. A recess in the case protects the binding posts, of the spring-locking type, from breakage.

Instruments for Indicating and Recording Position and Thickness

GRAPHIC instruments especially adaptable to recording the position of dampers, valves, gates, etc., height of water in tanks, head of water in reservoirs and similar meas-



Recorder and transmitter arranged to record depth of coal on a conveyor and the height of water in a reservoir

urements, also the thickness of coal on a belt conveyor or of various materials in manufacturing process, is a recent product of the Esterline-Angus Company, Indianapolis, Ind.

A shows the general outline of the instrument and a position transmitter with interconnecting leads. *B* and *C* show the instrument applied to the measuring of coal on a belt conveyor and to recording the height of liquid in a tank, respectively.

Two types of transmitters are used. The one shown in *B* is operated by a lever extending through the bottom of the case, and the one in view *C* is operated by the rotary motion of a shaft, the operating principle being the same in both cases. A movement of 0.40 in. by the plunger of the transmitter causes full scale movement of the recorder pen. The rotary type is designed so that a shaft rotation of 180 deg. corresponds to full scale on the meter. The system may be operated from either 110 or a 220-volt, 60-cycle circuit, and the reading is said to be independent of ordinary voltage variations.

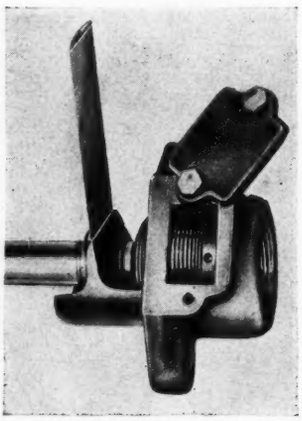
For installation where the recording instrument can be placed close to the machine on which the position or thickness is to be recorded a mechanically operated recorder is available. In this instrument the actuating rod extends horizontally through both sides of the case, permitting attachment of the operating mechanism on either side.

Both the electrically and mechanically operated instruments are furnished in standard switchboard, wall- and portable-type cases. Standard eight-day clocks or synchronous motor-driven clocks are available in speeds of $\frac{3}{4}$, $1\frac{1}{2}$, 3, 6 and 12 in. an hour and the same per minute. Indicating meters can also be furnished.

Single-Stage Centrifugal Pump Has Single-Vane Impeller

RADICAL DEPARTURE in impeller design characterizes the new single-stage centrifugal pump (Type-Q) for handling small volumes of water or other liquids at high pressures recently developed by the American Steam Pump Company, Battle Creek, Mich.

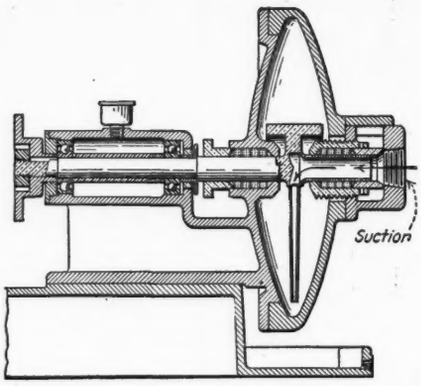
As will be apparent from the illustration, the impeller consists of the hub, suction tube and a hollow vane of streamline section with knife



View of impeller and outboard stuffing box

edges. The vane is a stamping welded to the hub. The shaft, impeller hub and suction tube are cast in one piece from stainless steel. Water or other liquid is drawn in at the center, as indicated by the arrows, and discharged through the wane at high velocity. This design, it is claimed by the manufacturer, gives exceptionally high efficiencies.

The casing is of the single-suction type, with the inboard head and bearing pedestal cast integral. The inboard stuffing box is of the split-bolted type, while the box on the suction tube is of the screwed type, being accessible through the handhole, as shown.



Sectional view of type Q pump

Two deep-groove ball bearings mounted in sealed housings carry the entire load of the shaft and impeller, and a flexible coupling is used to connect the pump shaft to the motor. The pump is made in a range of capacities from 5 to 35 gal. per minute for heads from 40 to 300 feet.

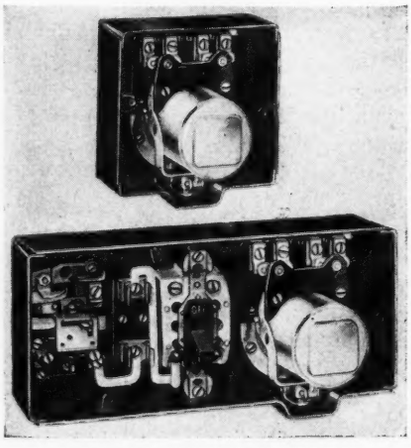
Automatic Pressure Starting Switch

A PRESSURE switch for starting and stopping compressor and pump motors that is exceptionally compact and occupies an unusually small space is announced by the Allen-Bradley Company, 286 Greenfield Ave., Milwaukee, Wis.

The size *B* switch is made in four forms in various combinations with or without overload breakers, disconnect switches and fuse clips. This unit is rated at 1 hp., 110-220 volts for direct current; and 1 hp., 110-volts, and 2 hp., 220-volts, for alternating current.

The size *C* switch is rated up to 5 hp. For larger ratings, the size *B* pressure switch is used as a pilot control for magnetic starters of any rating.

Two types of pressure starting switch



NEWS of the FIELD

Spot News

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BY A NEW SYSTEM *of distribution, natural gas service is made available to every community on the Pacific Coast by the Natural Gas Corporations of California, Oregon and Washington, all three subsidiaries of the Standard Oil Company of California. Under the new plan liquified natural gas will be shipped in tanks from the Kettleman Hills oil field to the various communities, where it will be subjected to a carburetion process at a local plant and delivered through an ordinary gas distribution system.*

•

CREATION *of the first $2,000,000,000 public utility system in the United States, through a merger of the Consolidated Gas Company of New York and the Niagara Hudson Power Corporation, may be effected this year, in the opinion of financial and utility executives. The company formed by this merger would have the largest interconnected power load in the world, with an annual output exceeding ten billion kilowatt-hours.*

•

IN ORDER TO SPAN *the Mississippi River with a 66,000-volt power line connecting the new Baton Rouge, La., steam plant with the Gulf States Utility system at Beaumont, Texas, the Baton Rouge Electric Company has submitted plans to the War Department calling for two 427-ft. riverbank towers. It is believed that these will be the highest structures of their kind in the world.*

•

SUBJECT *to the ratification of the shareholders, the sale (mentioned in last week's issue) of the Dominion Power & Transmission Company, Ltd., to the Hydro-Electric Power Commission of Ontario, Canada, has been completed, according to an official announcement of C. A. Magrath, chairman of the commission. The purchase price of $21,250,000 makes this the second largest deal ever engineered by Ontario's public-owned power system.*

Old and New Steam Generating Units Present Striking Contrast

Remarkable development of boilers is seen in comparison of new Kips Bay unit with 1882 Heine boiler added to Ford collection

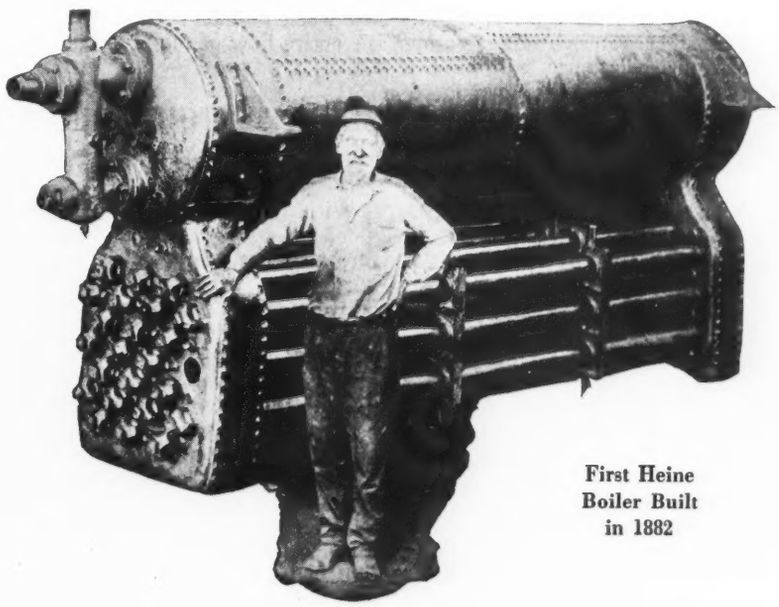
THE STRIKING CONTRAST between the enormous new steam generating unit just ordered for Kips Bay Station in New York City and the first Heine water-tube boiler recently added to the collection at the Ford Industrial Museum in Detroit, Mich., calls attention to the exceptional progress made during the last 50 years in the art of steam generation.

Exactly 750,000 lb. of steam per hour from a unit occupying approximately the same area as units designed to produce 325,000 lb. per hour, is the capacity guaranteed on the contract for the new unit designed and manufactured by Combustion Engineering Corporation for installation at Kips Bay Station of the New York Steam Corporation. When operating at maximum capacity it will require 64,000 lb. of coal per hour. This unusual installation comprises a 34,350-sq.ft. double Ladd type boiler tangentially fired by pulverized coal. The furnace is comprised of bare-tube, all-metal, water-cooled furnace walls, with plate-type air preheaters.

On the other hand, among the exhibits recently received at the Ford Industrial Museum is the first Heine water-tube boiler, shown below. This boiler was sold to the First Regiment Armory Association in St. Louis, Mo., and installed during 1882, continuing in service until the Armory was destroyed by fire in 1917. Later it was salvaged by the Heine Boiler Company and placed on exhibit at their shop in St. Louis.

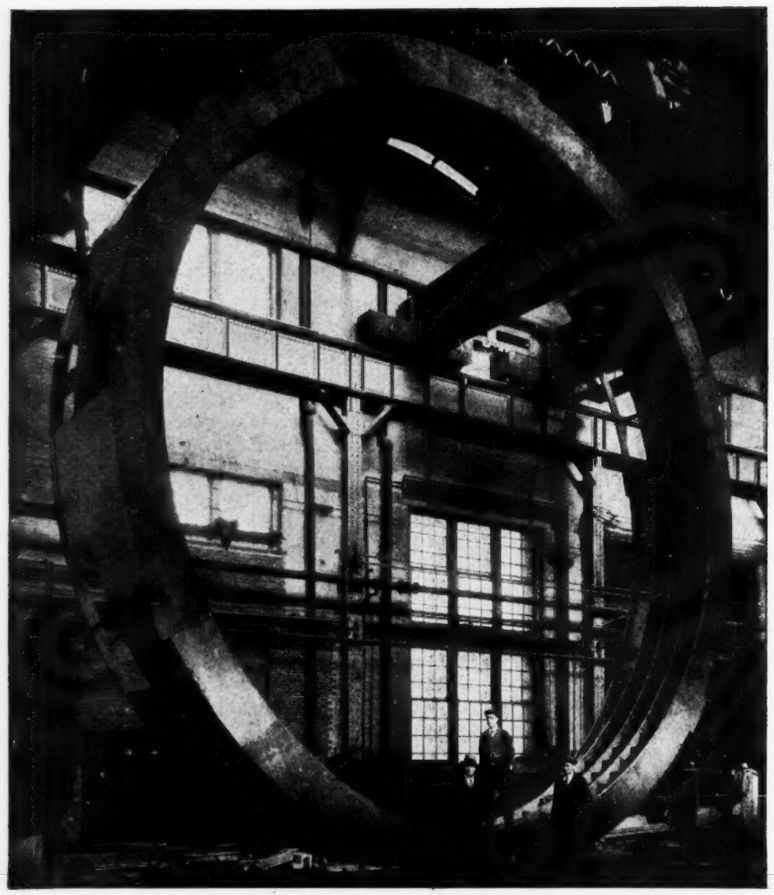
It is interesting to compare the steam output of this boiler with one of the steam generating units recently placed in operation at the East River Station of the New York Edison Company which has produced steam at the rate of 1,250,000 lb. per hour. If this first Heine boiler had operated continuously for the entire 48 years since it was built, 24 hours a day, 365 days a year, it would have produced approximately the same amount of steam, in nearly a half-century, as the New York Edison unit could produce at maximum rating in less than 11 days. It would require 1,580 boilers each having the capacity of the original Heine boiler built 48 years ago to equal the steam production of one of the new units in the East River Station.

When constructed the first Heine boiler was representative of the best practices in boiler building at that time. As compared to present-day standards, however, it illustrates how tremendous has been the advance.



First Heine Boiler Built in 1882

Giant Waterwheel Generating Unit for Spier Falls, N. Y., Plant



100,000-lb. armature frame for Spier Falls generator

AMONG the largest water-driven machines anywhere, as to physical dimensions, is the new generating unit to be installed this year in the hydro-electric plant of the New York Power & Light Corporation at Spier Falls, on the Hudson River. It will be capable of producing 57,000 hp. of energy. At present the Spier Falls station has eight waterwheel generating units, but the newcomer will have a greater capacity than the eight combined.

Only the generators at Niagara Falls and at Conowingo, on the Susquehanna, will exceed the new Spier Falls machine in this country. Its electrical capacity, 47,000 kva., puts its second among the three; its height, 24 ft. 2 in., puts it third, and in weight, 994,000 lb., it is also third. In over-all diameter, however, it stands first, measuring 43 ft. across.

So large is the frame for the stationary element that it is being made in six sections at the Schenectady Works of the General Electric Company. It will be shipped unassembled and without the coils and windings, which, because of their weight, would greatly increase the difficulty of transportation, especially as the last few miles must be covered by motor tractor, owing to the absence of a railroad track to the generating station. If shipped as a complete ring, there would not be sufficient clearance on the railroad and it would be too massive for a motor truck, weighing 100,000 lb. by itself.

The machine is to be ready for service by Dec. 1. The waterwheel to drive it will be the largest ever built. During low water periods it will be able to take the entire flow of the Hudson.

Six N. Y. Utility Bills Held Up; Eighteen Go to Governor

With the New York State Legislature scheduled to adjourn *sine die* on April 11, five of the public service commission bills sponsored by the committee on revision of the public service commission law, are still held in the upper house of the legislature, the Senate unable to agree as to their passage.

The legislative leaders are expected to hold the legislature in session until action is taken on at least two of the five remaining bills, one of which is the state wide valuation bill and the other relates to stabilization of valuations and rate base by contract. The other three bills which are being held in the Senate and upon which no action was taken today are the bill in relation to submetering companies, the water company regulation bill and the bus bill. These latter two bills may be abandoned for this year if the first two mentioned bills are passed first and objections still continue as to their passage.

The assembly on April 9 passed and sent to the governor eighteen of the public service commission law amendments (See *Power* for March 11, page 411), which had previously passed the Senate. The only bill the Assembly did not pass out of the group is the Thayer bill making an appropriation to pay the cost and expenses of a state-wide valuation of public utility properties.

Electric Bond & Share Next in Utility Hearings

Next in the utilities inspection line at the Federal Trade Commission comes Electric Bond & Share Company, on April 16. In most respects, the development of facts regarding the parent firm and its subsidiaries will closely parallel the procedure followed with the American Gas & Electric Company a few weeks ago. Company officials have been conferring with commission examiners to agree on the line of questioning. The legal suit of the commission to obtain operating expense ledgers refused by the company apparently has no direct bearing on the inquiry at this time. The case still awaits the appointment of a special master by the New York district court. Meanwhile the probers will work under some handicap as to details though they will be able to obtain much of the expense information through sources other than the ledgers specifically involved in the suit.

Bill Proposes Regulation of Interstate Power

Reorganization of the Federal Power Commission and federal regulation of rates on certain sales of electric current transmitted interstate are provided in a bill introduced in the House April 4, by Representative Parker of New York, chairman of the House Committee on Interstate and Foreign Commerce. Similar to Senator Couzen's measure the bill provides for a commission of three members to be appointed by the President with the advice and consent of the Senate.

With respect to rates for electricity, the bill provides that Federal regulation shall apply in the case of sales by producers of electricity to distributors in other States, according to Mr. Parker's statement, but does not affect sales by producers to consumers in other States. Joint boards composed of State commissioners would be given power to administer rate regulation under the bill, with action by the Federal Power Commission in case of inaction or disagreement by the joint board.

Meet to Discuss Plans for Boulder Dam

A meeting of the Colorado River Board was held in Denver April 10 to consider Boulder Dam plans formulated by Reclamation Bureau engineers since the last session five months ago. The project plans are well advanced, awaiting authorization to go ahead with the work. The Union Pacific Railroad is to build a spur line to the site, but is authorized by the Interstate Commerce Commission to hold this job until a definite date is set for the start of construction. On the advisory committee are three engineers, Major-General W. L. Sibert (chairman), Robert Ridgeway and D. W. Mead; and two geologists, W. J. Mead and C. P. Berkey.

After the agreement between California groups as to the division of Boulder Dam power, government legal aides have been drawing up new contracts for the various parties in accordance with the terms proposed. The completion and final signature of these contracts is expected at an early date.

Appointment of a committee to determine the amount of power used last year by Southern California municipalities applying for Boulder Dam power was announced recently by Northcutt Ely, of the Department of the Interior, following a conference with representatives of Pasadena, Glendale, San Bernardino, Burbank, Colton, Riverside, Santa Ana, Newport Beach, Beverly Hills, Anaheim and Fullerton, at the city water and power offices. Formal notification was given him by those present of their willingness to accept the block of 6 per cent (about 228,000,000 kw.-hr.) of the Boulder Dam power allotted them and to divide it among themselves. The division will be made on a pro-rata basis of their consumption last year.

Attorney General Studying Cumberland Falls Tangle

Attorney General Mitchell has been asked to give an opinion regarding the effect of recent state legislation on the jurisdiction of the Federal Power Commission in respect to the Cumberland Falls application in Kentucky, according to a recent announcement by Ray Lyman Wilbur, Secretary of the Interior and acting chairman of the commission.

This application, which seeks government authorization for power development at Cumberland Falls, has been opposed by many interests desiring to have the site preserved in its natural state for park purposes. Some time ago the commission asked Attorney General Mitchell for an opinion as to several phases of its relationship to this disputed question. The opinion requested has not yet been rendered and action on the case has been suspended.

Meanwhile the Kentucky Legislature has enacted two laws designed to bring about the acquisition by the state for park purposes of the land controlling Cumberland Falls. In view of this legislation, the Attorney General of Kentucky has petitioned the Federal Power Commission to deny the pending application for power development. In answering this petition, the applicant company contends that recent state legislation does not stop the company from proceeding with the project and urges that the Federal Power Commission should either grant the license application or make a finding of no jurisdiction.

In discussing the situation, the Secretary of the Interior stated that the controversial questions of law raised by the recent state legislation would require study and opinion by the Attorney General of the United States before any further steps could be taken by the commission.

Industrial Steam Unit Ties in With Tacoma Supply

The addition of a new unit, consisting of a 12,000-sq.ft. boiler and a 1,000-kw. turbine-generator set, to the steam plant of the St. Paul & Tacoma Lumber Company, Tacoma, Wash., has been completed. The company entered into a contract with the Tacoma Municipal Light Department under which the city furnished the capital for the power plant addition to be repaid in auxiliary power during the coming five years. The company has been furnishing the city auxiliary power, as needed, for some years, but has been short of steam capacity for all its plant requirements, and for the generator sets of 2,500- and 3,000-kw. capacity, respectively.

The city's investment amounts to $65,000, and, according to Commissioner Ira S. Davisson, makes it possible for the city to obtain in emergencies several thousand kilowatts of capacity as needed, at 6 mills per kilowatt-hour. The supply also conserves the Lake Cushman water supply. The city's own steam plant cannot be completed until next fall.

Allied Engineers Acquires Stevens & Wood

B. C. Cobb, chairman of the board of the Commonwealth & Southern Corporation, announces that the Allied Engineers, Inc., has been organized to take over the assets, business and organizations of Stevens & Wood, Inc.; Dixie Construction Company; and Empire Construction Company. The new company will continue in the present location of Stevens & Wood, Inc., 60 John St., New York City, until about May 1, when it will move to its new headquarters at 120 Wall St. E. A. Yates, formerly vice-president of the Southeastern Engineering Company, will be chairman of the board, and B. F. Wood, formerly of Stevens & Wood, will be president of the new organization.

News of Canada

New waste-gas turbine being tested in Alberta—Shawinigan adds two new units—Ontario buys Foshay interests

UTILIZATION of the waste gas in Turner Valley oil fields of Alberta for power development, with a possible output of 120,000 electrical horsepower, is being tested out through the medium of a machine invented by Fred Hossell, of Calgary, Alberta. The first test was made at Foothills No. 1 well, assistance being given by members of the staff of the Royalite Company. Power was developed through a 2-in. pipe, which, fed through a 6-in. pipe into the turbine machine, was sufficient to pull a 6-ton truck with brakes locked out of rough potholes. Only one machine has been built as yet. It weighs 5½ tons, and when filled with 7,000 gal. of water the total weight is 40 tons. A company, Powers Limited, a closed corporation, has been organized to exploit the invention and a charter is being secured.

TWO NEW UNITS are being added to power plants in the Province of Quebec owned by the Shawinigan Water & Power Company. One of these, a 25,000-hp. unit is being installed in the plant at Grand 'Mere and will be ready for operation by next December. Work also is progressing on the installation of an additional unit of 30,000-hp. capacity at La Gabelle. The additional units at Grand 'Mere and La Gabelle are being completed at relatively small cost, as the power houses at these points have been up for some time, and the only additional work necessary is the installation of the machinery. The new units will increase the company's total installed capacity to 858,650 horsepower.

OFFICIAL NOTICE of the closing of negotiations by the Ontario Hydro-Electric Commission for the purchase of the Foshay power interests in the province was given April 5 by C. A. Magrath, chairman of the commission. Commenting on the proposed purchase, Mr. Magrath said:

"Negotiations have been in progress between the receiver, Joseph Chapman, and the commission for the past few weeks. An agreement practically has been reached by which the commission will pay about $520,000 for all the assets and properties of the Public Utilities Corporation in Ontario, including the generating plants at Walkerton and Southampton and on the Sauble River and the distributing systems in Walkerton, Southampton, Port Elgin, Cargill and Mildway, together with extensions that have been made into rural districts since the acquisition of the properties by the Foshay interests."

Death Takes J. D. Harper, Diesel Engine Expert

J. D. Harper, manager of the Diesel engine division of Fairbanks, Morse & Company, Chicago, Ill., died Sunday morning, April 6, of pneumonia. He was widely recognized as one of the foremost authorities on the Diesel engine in this country, having been associated with its development since his graduation from Rose Polytechnic Institute in 1891.

Mr. Harper was born in Indianapolis, Ind., on June 30, 1861. After his graduation from college he was instructor in engineering at Rose Institute and later at the University of Kansas. He first became associated with Fairbanks-Morse in 1901, when he was made manager of the Diesel engine division at St. Louis, Mo. In 1907 he was made manager of the Dallas sub-branch. In 1908 the Texas Machinery & Supply Company was organized and he was made president.

Ten years later this subsidiary was discontinued but he remained as manager of the Dallas Branch. Later, in 1920, he was transferred to the home office in Chicago as manager of the Diesel engine division. Of late he had been very closely identified with the activities of the Diesel Engine Manufacturers Association.

U. S. Government Wants Hydro and Mechanical Engineers

The United States Civil Service Commission announces the following open competitive examinations: Principal hydro-electric engineer, $5,600 to $6,400 a year; senior hydro-electric engineer, $4,600 to $5,200 a year; hydro-electric engineer, $3,800 to $4,400 a year; associate hydro-electric engineer, $3,200 to $3,700 a year; assistant hydro-electric engineer, $2,600 to $3,100 a year.

Applications for these positions must be on file with the Civil Service Commission at Washington, D. C., not later than May 7, 1930. The examinations are to fill vacancies occurring in the engineer department at large, War Department, throughout the United States, and in positions requiring similar qualifications.

Announcement is also made of an open competitive examination for a mechanical engineer at an entrance salary of $3,800 a year to fill a vacancy in the United States Veterans' Bureau, Washington, D. C., as senior mechanical inspector. Applications for this position must also be on file by May 7.

Competitors will not be required to report for examination at any place, but will be rated on their education, training, experience, and fitness. Full information may be obtained from the United States Civil Service Commission, Washington, D. C., or from the secretary of the United States Civil Service Board of Examiners at the post office or custom house in any city.

Coming Conventions

American Society of Mechanical Engineers. Semi-Annual meeting at the Hotel Book-Cadillac, Detroit, Mich., June 9-12, 1930. Secretary, Calvin Rice, 33 West 39th St., New York City.

American Institute of Electrical Engineers, District meeting at Springfield, Mass., May 7-10. Annual summer convention at Toronto, Canada, June 23-27. Secretary, F. L. Hutchinson, 33 West 39th St., New York City.

American Society of Heating & Ventilating Engineers. Annual summer meeting at the Curtis Hotel, Minneapolis, Minn., June 23-25. Secretary, A. V. Hutchinson, 33 West 39th St., New York City.

American Society of Refrigerating Engineers. Annual spring meeting at the Atlanta Biltmore Hotel, Atlanta, Ga., May 7-9. Secretary, David L. Fiske, 37 West 39th St., New York City.

American Society for Testing Materials. Annual meeting at Haddon Hall, Atlantic City, N. J., June 23-27. Secretary, C. L. Warwick, 1315 Spruce St., Philadelphia, Pa.

American Welding Society. Annual meeting at society headquarters in New York City, April 22-25. Secretary, M. M. Kelly, 33 West 39th St., New York City.

American Refractories Institute. Annual spring meeting at The Greenbrier, White Sulphur Springs, W. Va., May 19-20. Secretary, Dorothy Texter, 2202 Oliver Bldg., Pittsburgh, Pa.

Association of Iron and Steel Electrical Engineers. Annual convention and iron and steel exposition at Broadway Auditorium, Buffalo, N. Y., June 16-20. Managing director, John F. Kelly, Empire Building, Pittsburgh, Pa.

Canadian Electrical Association. Annual Convention at the Manoir Richelieu via the S.S. "St. Lawrence," June 11-13, 1930. Secretary, H. M. Lyster, 405 Power Building, Montreal, Quebec.

International Congress for General Mechanics at Liege, Belgium, Aug. 31 to Sept. 7, 1930. For information address Alb. Schlag, 4 Place Saint-Lambert, Liege, Belgium.

International Railway Fuel Association. Annual meeting at the Hotel Sherman, Chicago, Ill., May 6-9. Secretary, C. T. Winkless, Room 700, LaSalle St., Station, Chicago, Ill.

National Electric Light Association. Annual convention at Municipal Auditorium, San Francisco, Calif., June 16-20, 1930. Secretary, A. J. Marshall, 420 Lexington Ave., New York City.

National Oil and Gas Power Meeting, under auspices of A.S.M.E. Oil and Gas Power Division and Pennsylvania State College, will be held at State College, Pa., June 12-14. Chairman, L. H. Morrison, c/o *Power*, 10th Ave. and 36th St., New York City.

National Power Show. Held in connection with the International Textile Exposition at Mechanics Building, Boston, Mass., April 28 to May 3. For information, write to the New England Association of Commercial Engineers, 53 Devonshire St., Boston, Mass.

Second Plenary World Power Conference. Convenes at Berlin, German, June 16-25. Chairman of the American Committee, O. C. Merrill, Edmunds Building, Washington, D. C.

Personals

GEORGE W. MARTIN, for nearly twenty years president of the New York Service Company, consulting and operating engineers, has established an office as consulting engineer at 70 East 45th St., New York City, specializing in power and heating plants.

CHARLES E. THORNTON, Bronxville, N. Y., has been named senior assistant, utilities engineer of the Maryland Public Service Commission, Baltimore. Mr. Thornton is a graduate of the Massachusetts Institute of Technology. He succeeds Edgar R. Shepperd, resigned, to become associated with the Bureau of Standards.

E. A. CLEVELAND, chief commissioner of the Greater Vancouver Water District, has been authorized by the Vancouver City Council to conduct the Cheakamus watershed survey recently authorized at a cost of $25,000. The city is investigating this power source on which it holds water rights with a view to deciding whether it will go ahead with the projected municipal power development. Mr. Cleveland was formerly provincial controller of water rights, and in February, 1926, was appointed head of the Greater Vancouver Water Department.

HARRY E. DUNHAM, patent attorney with the General Electric Company since 1912, has been appointed assistant manager of the patent department, according to an announcement made by Charles E. Tullar, manager of the department.

A. C. FLORY, manager of the turbine department of the Allis-Chalmers Manufacturing Company, Milwaukee, Wis., sailed for Europe on April 12.

CHARLES A. HORN, for the last six years piping engineer with Stevens & Wood, Inc., of New York City, has joined the Durabla Manufacturing Company as consulting engineer with offices at 114-118 Liberty St., New York City.

R. F. SCHUCHARDT, chief electrical engineer of the Commonwealth Edison Company of Chicago, Ill.; FRANK M. GUNBY, associate of Charles T. Main, Inc., of Boston, Mass.; and A. A. POTTER, dean of the School of Engineering at Purdue University, Lafayette, Ind., are among those appointed by the American Engineering Council to co-operate in the publication of a new edition of "Who's Who in Engineering."

ROY R. BURNHAM has resumed the practice of consulting engineering with offices in Boston, Mass. Mr. Burnham recently resigned as treasurer of the Walworth, English & Flett Company, Boston, after about six years' association with that house. He was in independent engineering practice at Boston from 1919 to 1924.

Business Notes

THE CONNERSVILLE BLOWER COMPANY, Connersville, Ind., has awarded a contract for the immediate construction of a 25 x 125-ft. addition to its factory.

SARCO COMPANY, New York City, announces the appointment of Gus A. Binz as manager of sales promotion, which includes charge of advertising. Mr. Binz was for eight years manager of sales and advertising for the American Schaeffer & Budenberg Corporation and previously sales manager of the Yarnall-Waring Company.

SULLIVAN MACHINERY COMPANY, Chicago, Ill., announces the appointment of Morley S. Sloman as manager of its Huntington branch office to succeed John S. Walker, Jr., who has retired to engage in the banking business in Huntington.

THE LINCOLN ELECTRIC COMPANY, Cleveland, Ohio, announces the opening of the following new offices: 338 Barnard St., Saginaw, Mich., in charge of J. E. Luter; 225 East Columbia St., Fort Wayne, Ind., in charge of D. H. Carver; and Oil City, Pa., in charge of E. D. Anderson.

THOMAS GRATE BAR COMPANY, Birmingham, Ala., announces the appointment of Arvid Wickstrom, Providence Building, Duluth, Minn., as district sales agent for Minnesota, northern Wisconsin and northwestern Michigan.

WHITING CORPORATION, Harvey, Ill., announces the appointment of E. F. Lindsay as sales manager of its Harrington division. Mr. Lindsay will have charge of stoker sales.

SQUARE D COMPANY, Detroit, Mich., announces the appointment of C. E. Cook, formerly branch sales manager at Detroit, as an assistant sales manager of the company. E. L. Pittenger, formerly branch sales manager at Pittsburgh, Pa., has also been appointed an assistant sales manager. R. M. Heasley, formerly sales representative at Grand Rapids, Mich., succeeds Mr. Cook as Detroit branch sales manager, and R. R. Eckenrode, formerly sales representative at Philadelphia, Pa., succeeds Mr. Pittenger as Pittsburgh branch sales manager.

LUDLOW VALVE MANUFACTURING COMPANY, Troy, N. Y., announces the election of James H. Caldwell, for many years president and general manager, as chairman of the board. William H. Lolley, a director and general manager of the company, has been made president to succeed Mr. Caldwell.

ELECTRIC MACHINERY MANUFACTURING COMPANY, Minneapolis, Minn., announces that its Chicago office is now located in Room 1567, 20 North Wacker Drive Building, Chicago, Ill.

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With the SOCIETY SECTIONS

A.S.M.E., Detroit Section. Meeting at Detroit Engineering Society Club House on April 21 at 8 p.m. Subject: "Industrial Power Plants," by Garrett Burgess, president, Garrett Burgess, Inc.

A.S.M.E., Florida Section. Annual meeting of Florida Engineering Society at Ocala, Fla., on April 18 at 1 p.m. Annual election of officers.

A.S.M.E., Metropolitan Section. Inspection of Macy's plant, 34th St. and Broadway, New York, on April 30 at 7 p.m. Meeting at 8:15 p.m. in the Engineering Societies Building. Sponsored by the A.S.M.E. Oil and Gas Power Division. Subject: "Diesels in Store Buildings," by George Pogue, Eastern sales manager, Fulton Iron Works Company.

A.S.M.E., Philadelphia Section. Meeting at Engineers Club on April 22 at 8 p.m. Subect: "Design and Construction of Deepwater Power Station," by K. M. Irwin, mechanical engineer, United Gas Improvement Company.

A.I.E.E., Niagara Frontier Section. Meeting at Niagara Falls Power House No. 2 on April 18. Subject: "Use of Regulators in Industry," by J. H. Ashbaugh, regulator engineer of the Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa.

New England States Association of the National Association of Power Engineers. Annual convention and exhibition of power machinery at the State Armory, Salem, Mass., June 19-20, 1930. Secretary, E. S. Daniels, 113½ Bridge St., Salem, Mass.

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Trade Catalogs

INSTRUMENTS—Catalog 7501, entitled "Brown Remote Type Instruments," has just been issued by the Brown Instrument Company, Philadelphia, Pa. Fully illustrated in two colors, this 32-page publication shows in detail how the various instruments operate. Sectional views and wiring diagrams amplify the descriptive material.

REGULATORS—Bulletin No. 205, recently issued by Morey & Jones, Ltd., 922 South Hemlock St., Los Angeles, Calif., describes and illustrates regulators for combustion control. These regulators are particularly adapted to boiler pressure regulation, where it is desired to vary the fire and draft as the demand on the boiler varies.

HOISTS — Robbins & Myers, Inc., Springfield, Ohio, has just published illustrated Bulletin 5031, which contains detailed specifications on many types of electric hoists for industrial use.

METERS—The construction and use of electrical CO_2 meters is treated at length in a 24-page, illustrated bulletin, No. 781, of the Leeds & Northrup Company, 4901 Stenton Ave., Philadelphia, Pa. Included in the booklet is a brief discussion on the control of combustion. Other recent publications of the company are Catalog No. 20 on all types of galvanometers, Bulletin No. 536 on the power cable fault bridge, and Bulletin No. 950 on the Homo method applied to nitriding steel.

PIPE COVERINGS—Keasby & Mattison Company, Ambler, Pa., has just issued a new 114-page illustrated catalog describing Ambler asbestos products used in the conservation of heat and as fireproof building materials. Included in the pages of this bulletin are valuable tables of heat losses and engineering data.

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Fuel Prices

COAL

The following table shows the trend of the spot steam market in various coals, f.o.b. mines; mine run, except Pittsburgh gas slack:

Bituminous (Net Tons)	Market Quoting	Price per Ton
Navy Standard	New York	2.20 @ $2.30
Kanawha	Columbus	1.35 @ 1.50
Smokeless	Cincinnati	1.75 @ 2.25
Smokeless	Chicago	1.75 @ 2.25
S. E. Kentucky	Chicago	1.40 @ 1.60
Steam	Pittsburgh	1.40 @ 1.65
Gas Slack	Pittsburgh	.90 @ 1.10
Big Seam	Birmingham	1.35 @ 1.50
Anthracite (Gross Tons)		
Buckwheat	New York	$2.70 @ 3.00
Barley	New York	1.40 @ 1.50

FUEL OIL

New York—Apr. 10, f.o.b. Bayonne, N. J., 28@34 deg., Baumé, industrial use, tank-car lots, 4.75@5c. per gal.; f.o.b. Bayway, 36@40 deg., furnace, tank-car lots, 6c. per gal.

St. Louis—Mar. 28, tank-car lots, f.o.b. St. Louis, 24@26 deg., $1.520 per bbl., or 42 gal.; 26@28 deg., $1.620 per bbl.; 28@30 deg., $1.720 per bbl.; 30@32 deg., $1.77 per bbl.; 32@36 deg., gas oil, 4.276c. per gal.; 37@40 deg., distillate, 4.98c. per gal.

Pittsburgh — Apr. 1, f.o.b. local refinery, 30@34 deg., fuel oil, 4.5@4.75c. per gal.; 36@40 deg., 4.75c.

Philadelphia—Apr. 9, 13@19 deg., $1.05@$1.10 per bbl. or 42 gal.; 18 deg. plus, $1.475@$1.525 per bbl.; 23@27 deg., $2.00@$2.05 per bbl.

Cincinnati — Apr. 1, tank-car lots, f.o.b. local refinery, 24@26 deg. Baumé, 5.25c. per gal.; 26@30 deg., 5.5c. per gal.; 30@32 deg., 5.75c. per gal.

Chicago—Mar. 31, tank-car lots, f.o.b. Oklahoma, freight to Chicago, 90c. per bbl. or 42 gal.; 22@26 deg., 80c. per bbl.; 26@30 deg., 90c.@95c. per bbl.; 30@32 deg., $1.05@$1.10 per bbl.

Boston—Apr. 7, tank-car lots, f.o.b., 12@14 deg., Baumé, 3.3c. per gal.; 28@32 deg., 5c. per gal.

Dallas—Mar. 22, f.o.b. local refinery 26@30 deg., $1.25 per bbl. or 42 gallons.

New Plant Construction

COMPILED BY THE McGRAW-HILL BUSINESS NEWS DEPARTMENT, WHICH IS PREPARED TO FURNISH A MORE COMPLETE DAILY SERVICE TO THOSE WHO WISH IT

Ark., Paragould—City, J. T. Craig, Mayor, is having preliminary plans prepared for the construction of an electric light, power and heating plant. Estimated cost $225,000. W. A. Fuller Co., 2916 Shenandoah Ave., St. Louis, Mo., is engineer.

Conn., Hartford — House of Good Shepard, 170 Sisson St., is receiving bids for the construction of a home, including 45 x 180 ft. industrial building, 45 x 150 and 42 x 100 ft. childrens building and 42 x 64 ft. power house. Estimated cost $400,000. Gander, Gander & Gander, 17 Steuben St., Albany, N. Y., are architects.

Del., Wilmington—Delaware State Hospital, will soon award contract for the construction of a 2 story, 68 x 111 ft. power plant. C. R. Hope, DuPont Bldg., is engineer.

Fla., Sarasota — Sarasota Terminal Docks, Inc., reported, plans a cold storage warehouse and pre-cooling plant. Estimated cost $350,000. G. M. Ragon, Chn. County Comn., is interested.

Ill., Wilmette—City will soon award contract for the construction of a sewage system including pumping station, pumps, etc. Estimated cost $1,804,950. C. N. Roberts, 105 North Clark St., is engineer.

Ky., Danville—J. E. Butler, has made application to Federal Power Commission, for preliminary permit to construct a hydro-electric power plant and dam on the Big South fork of the Cumberland River in McCreary County to develop 53,000 hp.

Mass., Boston—Edison Electric Illuminating Co., 39 Boylston St., is receiving bids for the construction of a steam heating plant at Kneeland and Utica Sts. Bigelow, Wadsworth, Hubbard & Smith, 11 Beacon St., are architects. I. E. Moultrop, 39 Boylston St., is company engineer.

Mass., Boston—Transit Dept., 1 Beacon St., awarded contract for the construction of a power sub-station at Massachusetts Station and Boylston St. subway to J. A. Singarella, Park Sq. Bldg. Estimated cost $40,000.

Mass., Melrose (Br. Boston)—Boston Ice Co., 11 Deerfield St., Boston, subsidiary of Knickerbocker Ice Co., 41 East 42nd St., New York, N. Y., will soon award contract for the construction of a 1 story, 45 x 100 ft. ice manufacturing plant, here. G. L. Wier, 13 East 37th St., New York, is engineer. Also ice manufacturing plant at Revere. Estimated total cost $80,000.

Mass., Springfield—United Electric Light Co., 73 State St., will soon award contract for the construction of a 1 story, 85 x 155 ft. substation on Converse St. Estimated cost including equipment $300,000. McClintock & Craig, 458 Bridge St., are engineers.

Mass., Waltham (Boston P. O.)—City H. F. Beal, Supt. Public Works, is having plans prepared for the construction of a high pressure water plant including pump house, tank, etc. Estimated cost $40,000. Private plans.

Mich., Detroit—Dept. of Water Supply, will receive bids until Apr. 30, for part of substructure and all of superstructure of pumping station, also superstructure of filter building, etc. for new Springwells water station. G. H. Fenkell, 735 Randolph St., is engineer.

Mo., St. Louis—St. Andrews R. C. Church, c/o A. Mayer, 307 Hoffmeister Pl., awarded contract for the construction of a church and 31 x 41 ft. boiler house to Hercules Contracting Co., Wainwright Bldg.

Mo., Sikeston — City voted $150,000 bonds for the construction of an electric light and power plant. W. A. Fuller Engineering Co., 2916 Shenandoah Ave., St. Louis, is engineer.

Mo., Springfield — Springfield Ice & Refrigerating Co., 227 West Mill St., awarded contract for a 2 story, 80 x 100 ft. addition to cold storage plant to A. Simpson Co., 2150 Curtis St., Denver, Colo. Estimated cost $75,000.

New Jersey—Public Service Electric & Gas Co., 80 Park Pl., Newark, awarded contract for the construction of a 57 x 85 ft. electric sub-station at 338-344 Chestnut St., Newark, also 30 x 70 ft. electric sub-station at Elizabeth Ave. and South First St., Elizabeth to Public Service Production Co., 80 Park Pl. Estimated cost $65,000 and $40,000 respectively.

N. J., Atlantic City—Grad & Sanger, 521 5th Ave., New York, N. Y., Archts., are receiving bids for the construction of a 17 story hotel including steam heating, ventilation and refrigeration systems, boilers, elevators, etc. at Boardwalk between Chelsea and Montpelier Aves. for owner, c/o architects. Estimated cost $2,000,000.

N. Mex., Fort Stanton—Treasury Dept., Office of Supervising Architect, Washington, D. C., awarded contract the construction of a power house and laundry building here to Broome Electric Co., Amarillo, Tex.

N. Y., Brooklyn—R. Reimer, 189 Montague, plans addition to boiler plant at Nevins and Schemerhorn Sts. Estimated cost $125,000. I. Brooks, 26 Court St., is architect. Young Women's Christian Association is lessee.

N. Y., New York—Chanin Construction Co., 122 East 42nd St., plans the construction of a hotel at Central Park West and 72nd St. Estimated cost $18,000,000. Ball & Snyder, 40 East 34th St., are structural engineers. Clark, McMullen & Rielly, 101 Park Ave., are heating and ventilating engineers.

N. Y., New York — New York Central R.R. Co., 466 Lexington Ave., had plans prepared for the construction of a remote control substation at 338 Dyckman St. Estimated cost $100,000. F. B. Freeman, Ch. Engr.

N. Y., New York—Rubel Ice Co., 937 Fulton St., Brooklyn, will soon award contract for the construction of an ice manufacturing plant at Eagle Ave. and 158th St., here. Estimated cost $300,000. H. J. Nurick, 44 Court St., Brooklyn, is engineer.

Pa., Aspinwall — City of Pittsburgh, plans Brilliant pumping station including one motor driven pump and appurtenances. Estimated cost $50,000. C. M. Reppert, 420 City-County Bldg., Pittsburgh, is engineer. This is an emergency installation pending projected rebuilding of new station which will cost approximately $1,000,000.

S. C., Charleston—J. B. Howe, is having plans prepared for the construction of an ice plant. York Ice Machinery Co., 412 Houston St. N. E., Atlanta, Ga., is engineer.

Tex., Edna—Central Power & Light Co., Frost Bldg., San Antonio, awarded contract for the construction of a 30 ton ice plant here to H. E. Sulton, El Campo. Estimated cost $16,000. Total cost $40,000. Equipment contracts let.

Ont., Hamilton—Hamilton Electric System, 12 King St. E., awarded contract for electrical substation equipment, including transformers, switches, switchboards, etc., to Canadian Westinghouse Co. Ltd., 286 Sanford St. N. Estimated cost $40,000.

Ont., Simcoe—Norfolk Fruit Growers Association, J. E. Johnson, Mgr., awarded contract for a 4 story, 80 x 80 ft. cold storage plant to E. P. Muntz, Ltd., 1104 Temple Bldg., Toronto. Estimated cost $100,000.

P. I., Manila—Manila Electric Co., subsidiary of Associated Gas & Electric System, has work under way on the construction of a hydro-electric plant, 16,000 kw. capacity, also 110,000 v. transmission line. W. S. Barstow & Co. Inc., 50 Pine St., New York, N. Y., are contractors.

Equipment Wanted

Conveying and Refrigeration Equipment — Waterbury, Conn. — Fulton Markets Inc., C. Greenblatt, 330 West Main St., plans to purchase conveying and refrigeration equipment for proposed 2 story, 60 x 100 ft. cold storage plant on West Main St. Estimated cost $75,000.

Generator, Condenser, etc. — Pennsylvania — Borough of Etna, J. C. Armstrong, Clk., will receive bids until Apr. 23 for one 1,000 or 1,250 kw. turbine driven generator, condenser and appurtenances.

Pump — Kingston, Ont. — Kingston Public Utilities Commission, City Hall, plans the installation of a 7,000,000 g.p.d. electric driven centrifugal pump in waterworks pumping station. $5,000 to $7,500.

Pump—Watonga, Okla.—City is in the market for a 500 g.p.m. motor driven centrifugal pump for waterworks.

Pump and Motor—Bethany, Okla.—City is in the market for one 50 g.p.m. deep well pump and motor for waterworks.

Pumping Equipment—Samarcand, N. C.—Bd. of Directors, Samarcand Manor, D. D. Carroll, Chn., will receive bids until Apr. 28 for pumping equipment, etc., for proposed improvements to water purification plant.

Pumping Equipment—Winnipeg, Man.—City, M. Peterson, Clk., will receive bids until Apr. 21 for pumping equipment including motors with switching and controlling apparatus, air compressor, water meters, etc., for proposed waterworks.

Pumping Unit — Newark, N. J. — Passaic Valley Sewerage Commission, 24 Brandford Pl., will receive bids until Apr. 30, for the installation of a pumping unit, etc. at Newark Bay pumping station, Wilson Ave. Estimated cost $25,000.

Pumps—New Orleans, La.—Sewage & Water Board, will receive bids until May 21, for two 110 in. screw pumps approximate weight each 65,000 lb. complete with all necessary equipment for Drainage station No. 9.

Pumps, etc.—New Brunswick, N. J.—City Commission, will receive bids until Apr. 22 for three electrically driven centrifugal pumps, etc., for proposed waterworks improvements. Estimated cost $60,000.

Pumps, etc.—Clinton, Okla.—City will receive bids until Apr. 22 for pumps, etc., for proposed waterworks improvements. Estimated cost $600,000.

Pumps—Hamilton, Ont.—City, S. H. Kent, Clk., will receive bids until Apr. 19, for supply and installation of vertical sewage pumps at East Mountain sewage pumping station 1, 2 and 3.

Pumps, Motors—Belleville, Ont.—City, J. W. Holmes, Clk., City Hall, will receive bids until Apr. 23, for pumps, motors, etc. for proposed waterworks improvements. Estimated cost $300,000.

Refrigeration Machines — Annapolis, Md. — Bureau of Yards & Docks, Navy Dept., Washington, D. C., two automatic refrigeration machines each complete with cooling units or coils at Naval Acadamy, here.

Industrial Projects

Calif., Oakland—C. W. McCall, 1404 Franklin St., Archt., is receiving bids for the construction of a 3 story factory at 14th Ave. and East 14th St. for Caldow Paint Co., 1422 14th St. Estimated cost to exceed $40,000.

Calif., Placerville—Spicky Polish Co., 1401 3rd St., San Francisco, plans the construction of a glass sand refinery, here. Estimated cost $75,000.

Calif., Trona—American Potash & Chemical Co., 233 Broadway, New York, N. Y., has retained United Engineers & Constructors, Inc., 125 East 46th St., New York, to design and costruct large additions to facilities, here. The improvements will consist of a new power plant and extensions to potash and borax plants, etc. Estimated cost approximately $4,500,000.

Conn., New London—Connecticut Power Co., 33 Union St., awarded contract for extensions to gas manufacturing plant on Water St. to United Engineers & Contractors, 112 North Broad St., Philadelphia, Pa. Estimated cost to exceed $40,000.

Ill., Chicago — Continental Can Co., 4633 West Grand Ave., awarded masonry and carpentry contract for 3 story, 84 x 140 ft. factory at 4647 Grand Ave. W. Estimated cost $180,000.

Ill., East St. Louis—Key Boiler Equipment Co., 27th St. and McCausland Ave., awarded contract for a 1 story, 61 x 160 and 39 x 139 ft. addition to factory to Voelpel Building Co., 1113 Sidney St., St. Louis.

Md., Baltimore—Hinde & Dauch Paper Co., New Haven St. and Fairmount Ave., plans the construction of a 2 story factory at Biddle St. and Loney's Lane. Architect and engineer not selected.

Mass., Everett (Boston P. O.) — Merrimac Chemical Co., is having plans prepared for the construction of a power house at Chemical Lane. Estimated cost $50,000. Private plans.

Mass., Worcester—Melville Shoe Corp., Hammond St., will soon award contract for a 2 story addition to shoe manufacturing plant. G. E. Strehan, 33 West 42nd St., New York, is architect.

N. Y., Olean—New Olean Metal Cabinet Co., awarded contract for the construction of a factory to L. A. Harding Construction Co., 1335 Main St., Buffalo. Estimated cost $100,000.

O., Cleveland—Winton Engine Works, G. W. Codington, Gen. Mgr., 2116 West 106th St., awarded contract for the construction of a 2 story, 35 x 153 ft. factory to N. J. Burnham & Son, 1453 Alameda Ave. Estimated cost $40,000.

Tex., Marble Falls — Certified Laboratories, c/o G. H. Carter, Pres., Marlin and Marble Falls, plans the construction of a 3 story, 190 x 240 ft. plant for the manufacture of absorbent cotton and gauze here. Estimated cost $250,000. Private plans. Work will be done under owner's supervision. Most of machinery and equipment purchased.

Tex., San Antonio—Prest-O-Lite Co. Inc., 30 East 42nd St., New York, N. Y., awarded contract for the construction of a 1 story factory and storage building at Cassiano St. and Southern Pacific tracks here to Sumner Sollitt Co., National Bank of Commerce. Estimated cost $40,877.

W. Va., Newell—Homer Laughlin China Co., awarded contract for the construction of a 1 story kiln building to Harrop Ceramic Service Co., 310 West Broad St., Columbus, O. Estimated cost $60,000.

B. C., Vancouver — Pacific Mills Ltd., 510 Hastings St. W., awarded contract for a 2 story, 135 x 250 ft. factory for specialty paper manufacture on Raymond Ave. to E. H. Shockley, 230 Central St. Estimated cost $150,000.